Engineering

SEP 19 1930

The Engineer.

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PUBLIC NOTICES

Crown Agents for the COLONIES.
COLONIAL GOVERNMENT APPOINTMENTS.

APPLICATIONS from qualified candidates are INVITED for the following POST :—

M/2065.—ASSISTANT ENGINEER REQUIRED by the GOVERNMENT of TANGANYIKA TERRITORY for Roads Construction, for a tour of 20 to 30 months' service. Salary £480 to £600 a year, according to experience and qualifications. Outfit allowance of £30 on first appointment. Free quarters and passages and liberal leave on full salary. Candidates, 28-35 years of age, must have had experience of Railway or Road Contracting Engineer's Work abroad. Must be able to undertake the Construction of Earth and Gravelled Roads, including Earthworks, Steel, Reinforced Concrete and Timber Bridges and Auxiliary Works. Preferably should have had experience in Survey and Location Works, and preferably should be Associate Members of the Institution of Civil Engineers.

Apply at once by letter, stating age, whether married or single, and full particulars of qualifications and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W. 1, quoting M/2065. 5711

Ceylonese, Aged 23, B.A. (Cantab) Engineering, DESIRES EXPERIENCE in Mechanical or Electrical Engineering as ASSISTANT under agreement for two years.—Apply, DIRECTOR OF COLONIAL SCHOLARS, c.o. the Crown Agents for the Colonies, 4, Millbank, S.W. 1, quoting reference O/Sch. Wick. 5710

UNIVERSITY OF LONDON.

King's College.

FACULTY OF ENGINEERING.

CIVIL, MECHANICAL, ELECTRICAL and CHEMICAL ENGINEERING.

COMPLETE COURSES of STUDY, extending over three years, are arranged for the Engineering Degrees of the University of London and for the Diplomas and Certificate of the College.

POST-GRADUATE COURSES in CIVIL, MECHANICAL, ELECTRICAL and CHEMICAL ENGINEERING are also provided.

HEADS OF DEPARTMENTS :

Professor A. H. JAMESON, M.Sc., M. Inst. C.E., Civil Engineering (Dean).
C. H. LOBBAN, D.Sc., A.M. Inst. C.E., Reader in Civil Engineering.
Professor J. K. CATTERSON-SMITH, M.Eng., M.I.E.E., Electrical Engineering.
F. S. ROBERTSON, M.I.E.E., Senior Lecturer in Electrical Engineering.
Professor G. COOK, D.Sc., M.I. Mech. E., M. Inst. C.E., Mechanical Engineering.
S. J. DAVIES, M.Sc., Ph.D., M.I. Mech. E., Reader in Mechanical Engineering.
H. W. CREMER, M.Sc., F.I.C., M.I. Chem. E., Chemical Engineering.
Professor S. A. F. WHITE, M.A. } Mathematics.
Professor A. E. JOLLIFFE, M.A. }

Considerable extensions have been made in the Engineering Department. These include a large additional drawing-office, lecture room and laboratory for Hydraulics and Strength of Materials in the Civil and Mechanical Departments, and research rooms, including Wireless Telegraphy, in the Electrical Engineering Department. Large additions have been made to the equipment of the Laboratories in the four Departments for purposes of teaching and research.

There is a College Hostel and a large Athletic Ground.

For full information apply to the SECRETARY, King's College, Strand, W.C. 2. 5448

ADMINISTRATIVE COUNTY OF LONDON.

L.C.C. School of Engineering AND NAVIGATION,
HIGH STREET, POPLAR, E. 14.

Principal : J. PALEY YORKE, M.Sc., A.M.I.E.E.

MECHANICAL ENGINEERING DEPARTMENT.

Major courses in mechanical, marine and civil engineering, and minor courses in mechanical engineering will commence on

MONDAY, 22ND SEPTEMBER, 1930.

(ENROLMENT during week commencing 15th September, 1930.)

The major courses are "recognised" for the National Certificates in mechanical engineering both senior and advanced.

Courses are provided for the examinations for A.M.I. Mech. E. and A.M.I.C.E., and for those wishing to join the Royal Navy and Royal Air Force.

Special courses are also provided on Boiler House Engineering, Smoke Abatement and Engineering Economics.

Prospectus and full particulars can be obtained from the Secretary at the school.

MONTAGUE H. COX,
Clerk of the London County Council.
5686

University of Manchester.

PHYSICS DEPARTMENT.

Full particulars of the LECTURES and LABORATORY COURSES in PHYSICS, preparing for both the Ordinary and Honours Degrees will be forwarded on application to the REGISTRAR.
The SESSION COMMENCES on THURSDAY, OCTOBER 2nd. 5578

The Engineer

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PUBLIC NOTICES

Northampton Polytechnic INSTITUTE.
ST. JOHN-STREET, LONDON, E.C. 1.
EVENING COURSES IN
FUEL TECHNOLOGY AND METALLURGY.

FUEL TECHNOLOGY COURSES for Combustion and Power House Engineers comprise—
LECTURES on the Chemistry of Combustion and the Thermal Efficiencies of Furnaces.
LABORATORY WORK dealing with Calorimetry, Fuel and Gas Analysis, the Examination of Feed Water and allied subjects.
METALLURGY COURSES for Engineers deal with the Extraction, Physical Properties, Commercial Application and Heat Treatment of Ferrous and Non-ferrous metals, while the Laboratory Work includes the Microscopic Examination of those products.
SESSION COMMENCES, SEPTEMBER 22nd, 1930.
Enrolments commence, September 15th, 1930.
Prospectus on application to—
5688 THE PRINCIPAL.

The Royal Technical College, GLASGOW.

DEPARTMENTS OF ENGINEERING.

MECHANICS AND MECHANICAL ENGINEERING :
Professor ALEXANDER L. MELLANBY, D.Sc., M.I. Mech. E.
Associate Professor WILLIAM KERR, Ph.D., A.R.T.C., M.I. Mech. E.
ELECTRICAL ENGINEERING :
Professor STANLEY PARKER SMITH, D.Sc., M.I.E.E., A.M. Inst. C.E.
CIVIL ENGINEERING :
Professor GEORGE MONCUR, B.Sc., M. Inst. C.E., M. Amer. Soc. C.E.
MINING ENGINEERING :
Professor DANIEL BURNS, M. Inst. M.E.
CHEMICAL ENGINEERING :
Professor of Technical Chemistry : THOMAS GRAY, D.Sc., LL.D., Ph.D., F.I.C.

Complete courses of instruction are provided, qualifying for the Diploma and Associateship of the College and for the Degree of B.Sc. in Engineering of Glasgow University.
Composition fee, 25 guineas per annum.
SESSION 1930-31 BEGINS on TUESDAY, SEPTEMBER 23rd.
Calendar, by post 2s., and prospectus, gratis, may be obtained on application to the SECRETARY.
5365

PUBLIC NOTICES

City of Cardiff Education COMMITTEE.
THE TECHNICAL COLLEGE.
PRINCIPAL - CHARLES COLES, B.Sc. (Lond.).
DEPARTMENT OF ENGINEERING.
HEAD OF DEPARTMENT : A. W. LOVERIDGE, B.Sc. (Eng.), A.R.C.Sc.
SESSION 1930-31.
(Commencing on Monday, 6th October, 1930.)
The following COURSES have been arranged for ENGINEERING STUDENTS :—
A THREE YEARS' COURSE in MECHANICAL and MARINE ENGINEERING, jointly with the University College of South Wales and Monmouthshire.
A TWO YEARS' COURSE for APPRENTICES and others with facilities for practical experience in the Summer Term.
These Courses are suitable for students preparing for Degrees in Engineering or for the Examinations of the Engineering Societies.
SPECIAL COURSES are also arranged for MARINE ENGINEERS preparing for the Examinations of the Board of Trade.
OPEN SCHOLARSHIPS, covering tuition fees and maintenance grants of £40 per annum for three years, are offered for competition annually, and candidates for entry to the above Department are eligible to compete.
For further particulars of Full-time and Part-time Courses, Entrance Examination, Scholarships, Fees, &c., apply to the Principal. Application Forms for Entrance Scholarships Examination, duly filled up, must be received before September 20th.
W. J. WILLIAMS,
5669 Director of Education, City Hall, Cardiff.

Heriot-Watt College, Edinburgh

DEPARTMENTS OF MECHANICAL ENGINEERING AND ELECTRICAL ENGINEERING.

MECHANICAL ENGINEERING :
PROFESSOR A. R. HORNE, O.B.E., B.Sc., M.I. Mech. E., A.M.I.C.E.
ELECTRICAL ENGINEERING :
PROFESSOR F. G. BAILY, M.A., M.I.E.E.
FULL-TIME DAY DIPLOMA COURSES leading to professional recognition.
CLASSES COMMENCE 14th OCTOBER.
Full particulars from the College.
J. CAMERON SMAIL, O.B.E., Principal.
5304

PUBLIC NOTICES

Northampton Polytechnic INSTITUTE.
ST. JOHN-STREET, LONDON, E.C. 1.
EVENING CLASSES IN
ENGINEERING.
All branches of Civil, Mechanical, Electrical, Aeronautical, Automobile, and Radio Engineering.
APPLIED CHEMISTRY.
Fuels, Electro-plating, Metallurgy, &c.
CLASSES COMMENCE 22nd SEPTEMBER.
Enrolments during the week commencing 15th September.
Free prospectus on application to—
S. C. LAWS, M.A., M.Sc., Principal.
5653

CITY OF LONDON.

The Sir John Cass Technical INSTITUTE,
JEWRY STREET, ALDGATE, E.C. 3.

METALLURGY for ENGINEERS:
ALSO
EVENING UNIVERSITY COURSES.

The following COURSES MEET the REQUIREMENTS of ENGINEERS and those wishing to prepare for the degree of B.Sc. (Eng.) in Metallurgy of London University :—

GENERAL METALLURGY.
ELECTRO-METALLURGY.
METALLURGICAL ANALYSIS AND ASSAYING.
FUEL AND REFRACTORIES.
METALLOGRAPHY, PYROMETRY AND HEAT TREATMENT.
MECHANICAL TESTING OF METALS AND ALLOYS.
GEOLOGY AND MINERALOGY.

NEW SESSION COMMENCES SEPTEMBER 22ND, 1930.
ENROLMENT on and after September 17th, 5.30 to 8.30 p.m.

For details of the courses apply at the Office of the Institute, or by letter to
GEO. PATCHIN, A.R.S.M., M.I.M.M., *Principal.*

County Borough of Croydon EDUCATION COMMITTEE.

TEACHERS are REQUIRED in the following subjects, evening instruction 7.30-9.30, in the Mechanical Engineering Department of the Croydon Polytechnic for next Winter Session, commencing September 22nd.
First Year—ENGINEERING DRAWING, Fridays.
Second Year—ENGINEERING SCIENCE LABORATORY (HEAT, ELECTRICITY and MAGNETISM).
Third Year—ENGINEERING SCIENCE LABORATORY (MECHANICS and HYDROSTATICS).

The fees vary from 15s. per evening of two hours for the lowest appointments to 18s. for the highest, according to qualifications.
Applications, giving particulars of age, education, practical training, experience, present appointment, and residence, should be addressed to the PRINCIPAL, Central Polytechnic, Croydon.
E. B. MORGAN,
Education Officer.
Education Office,
Katharine-street. 5606

Bengal-Nagpur Railway Company, LIMITED.

The Directors are prepared to receive TENDERS for :—
32 H.S.M. LOCOMOTIVE BOILERS.
Specification and form of Tender can be obtained at the Company's Offices, 132, Gresham House, Old Broad-street, London, E.C. 2, on or after Wednesday, 3rd September, 1930.
A fee of 20s. will be charged for each copy of the specification, which is not returnable.
Tenders must be submitted not later than Noon on Tuesday, 16th September, 1930.
The Directors do not bind themselves to accept the lowest or any Tender, and reserve to themselves the right of reducing or dividing the order.
By order of the Board,
E. GRANT, Secretary.
5705

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PUBLIC NOTICES

Administrative County of LONDON.

The London County Council invites TENDERS for the INSTALLATION at the Lewisham Hospital, Lewisham, S.E. 13, of a LANCASHIRE STEAM BOILER and FITTINGS, including the necessary Brickwork, Setting, &c.

The specification, form of Tender, &c., may be obtained on application to the Chief Engineer, the Old County Hall, Spring-gardens, S.W. 1, upon payment of £1 by cheque, draft or money order, to the order of the London County Council. This amount will be returnable only if the tenderer shall have sent in a bona fide Tender and shall not have withdrawn same. Full particulars of the work may be obtained on personal application and the contract documents may be inspected before payment of the fee.

Remittances by post should be addressed to the Chief Engineer, the Old County Hall, Spring-gardens, S.W. 1. Personal inquiries at Room 3A, No. 3, Warwick House-street, Cockspur-street, S.W. 1.

The contractor will be bound to observe the provisions of a fair wages clause, the terms of which are set out fully in the instructions for Tender and form of contract, and in "The London County Council Gazette."

No Tender received by the Clerk of the Council at the County Hall, Westminster Bridge, S.E. 1, after 4 p.m. on Thursday, 25th September, 1930, will be considered.

The Council does not bind itself to accept the lowest or any Tender.

MONTAGU H. COX,
5708 Clerk of the London County Council.

Administrative County of LONDON.

The London County Council invites TENDERS for the INSTALLATION of a BAKER'S OVEN in the kitchen at Claybury Mental Hospital, Woodford Bridge, Essex.

The specification, form of Tender, &c., in respect of the work may be obtained on application to the Chief Engineer, the Old County Hall, Spring-gardens, S.W. 1, upon payment of £1 by cheque, draft or money order to the order of the London County Council. This amount will be returnable only if the tenderer shall have sent in a bona fide Tender and shall not have withdrawn the same. Full particulars of the work may be obtained on personal application and the contract documents may be inspected before payment of the fee.

Remittances by post should be addressed to the Chief Engineer, the Old County Hall, Spring-gardens, S.W. 1. Personal inquiries at Room 3A, No. 3, Warwick House-street, Cockspur-street, S.W. 1.

The contractor will be bound to observe the provisions of a fair wages clause, the terms of which are set out fully in the instructions for Tender and form of contract and in "The London County Council Gazette."

No Tender received by the Clerk of the Council at the County Hall, Westminster Bridge, S.E. 1, after 4 p.m., on Friday, 19th September, 1930, will be considered.

The Council does not bind itself to accept the lowest or any Tender.

MONTAGU H. COX,
5694 Clerk of the London County Council.

City of Carlisle.

18IN. DIAMETER CAST IRON MAIN FROM CUMWHINTON TO CARLISLE.

TENDERS are INVITED from competent Contractors for the SUPPLYING and LAYING of about 4¼ Miles of 18in. diameter CAST IRON PIPES and subsidiary pipes from the Service Reservoir at Cumwhinton to Carlisle, and the Construction of Chambers, &c.

General conditions, specification, bill of quantities, form of Tender, &c., may be obtained at the office of the undersigned on and after the 5th September, 1930, when the drawings may be inspected, on payment of Two Guineas, returnable upon receipt of a bona fide Tender and the return of the documents supplied.

Tenders, endorsed "18in. Diameter Cast Iron Trunk Main," must be delivered to my office not later than 10 a.m. on Monday, 29th September, 1930.

The Council does not bind itself to accept the lowest or any Tender and parties tendering must do so at their own cost.

PERCY DALTON,
A.M. Inst. C.E., A.R.I.B.A.,
City Water Engineer.
18, Fisher-street, Carlisle,
29th August, 1930. 5695

Applications are Invited from persons possessing the qualifications of A.M.I.C.E., B.Sc. (Eng.), &c., or the equivalent, for the POST of ASSISTANT ROAD ENGINEER in the Roads Department of Southern Rhodesia.

The initial salary will be at the rate of £400 per annum, and the appointment will, in the first instance, be on a temporary basis. If the services of the successful applicant are retained, increments will be governed by the regulations controlling scales of salary for professional and technical officers.

Applicants must state age and submit copies of testimonials with full statement of qualifications and experience, also stating the earliest date on which it is possible to assume duty.

The selected candidate will be required to pass a stringent medical examination by the Government's doctor in London.

Preference will be given to unmarried men below the age of 35.

Canvassing will disqualify the applicant.

Applications should be addressed to the HIGH COMMISSIONER FOR SOUTHERN RHODESIA, Crown House, Aldwych, London, W.C. 2, by the 7th September, 1930. 5689

Corporation of London.

TOWER BRIDGE.

The Bridge House Estates Committee are prepared to receive APPLICATIONS for the POSITION of SUPERINTENDING ENGINEER and BRIDGE-MASTER of the TOWER BRIDGE.

The salary of the position will be £750 per annum (no bonus), with residence, fuel and light.

Particulars of the duties of the position and forms of application may be obtained from the Town Clerk, Guildhall, London, E.C. 2.

Applications on the prescribed form must reach the Town Clerk's Office not later than Saturday, the 13th September, 1930. 5652

SITUATIONS OPEN

COPIES OF TESTIMONIALS, NOT ORIGINALS, UNLESS SPECIFICALLY REQUESTED.

WANTED, by Well-known Manufacturers of White Metal Alloys, ENGINEER with Railway experience to travel abroad. Full particulars in confidence.—Address, P225, The Engineer Office. P225 A

WANTED, IMMEDIATELY, Smart SALES ASSIST., Plant Machinery Section. Engineering business, London; capable handling, internal office work. Experience, refs., age, &c.—Address, P219, The Engineer Office. P219 A

ENGINEER REQUIRED.

The BENNETT COLLEGE has a VACANCY for a qualified ENGINEER in its tutorial department. Whole-time appointment; knowledge of Mechanical Engineering essential.

Apply, giving full details of qualifications and experience, and stating salary desired, to the GOVERNORS, The Bennett College, Sheffield. P213 A

INSTRUMENT WORKS.—SEVERAL Experienced PROGRESSIVE MEN REQUIRED, capable organisers, sound controllers of labour, conversant practical methods mass production lines. Only applicants with these qualifications will be considered.—Address, 5709, The Engineer Office. 5709 A

LONDON PATENT AGENTS REQUIRE ASSISTANT to Undertake and Supervise Technical and Professional Work in all branches. Interviewing clients and generally deputising on behalf of principals. Salary up to £500 p.a., according qualifications. Address, 15685, The Engineer Office. 5685 A

SITUATIONS OPEN (continued)

MARINE OIL ENGINE SALES DEPARTMENT.—REQUIRED, by British Firm of Manufacturers, highly qualified ENGINEER, fully conversant with Sales and Installation Requirements in Heavy Oil Engines up to 400 B.H.P. Applicant must be first-class man able to influence Marine Engine business.—Please write fully, stating age, experience, qualifications and salary required, to Box 186, Advertising Offices, 84, Queen Victoria-street, E.C. 4. 5707 A

PUBLIC SERVICE ORGANISATION.—APPLICATIONS are INVITED for an APPOINTMENT Abroad in Europe to investigate the possibility of and develop establishment of Road Public Service Organisations in undeveloped territory. Actual experience of Traffic and financial considerations necessary. Full particulars.—Address, 5698, The Engineer Office. 5698 A

REQUIRED, for a Temporary Post in a Government Department, an experienced MAN for the Production of Dies for Aluminium Die Casting and of Moulds for Rubber Working. Wages 45s., plus 14s. (Engineering advances); total 59s. per week. Ex-Service applicants (if any) given preference.—Write, giving full particulars, regarding experience, etc., to COMMANDANT, Experimental Station, Porton, nr. Salisbury, Wilts. 5704 A

TRAVELLER, with Connection in London and South, WANTED for Grey Iron Castings.—Address, P202, The Engineer Office. P202 A

WORKS MANAGER REQUIRED for Small General Engineering Works on outskirts of London.—Address, stating experience and salary required, P227, The Engineer Office. P227 A

WANTED, Fully Qualified DRAUGHTSMAN for Air Compressor Work.—BROOM and WADE, Ltd., High Wycombe. 5702 A

DRAUGHTSMEN, First-class Men, REQUIRED, preferably with Aero. Engine experience.—Write, stating age, full experience and salary required, 5693, The Engineer Office. 5693 A

DRAUGHTSMEN. — SEVERAL FIRST-CLASS DRAUGHTSMEN, with experience of Water-tube Boiler Design, are WANTED IMMEDIATELY for the North-East Coast.—Address, stating age, experience and salary required, 5692, The Engineer Office. 5692 A

DRAUGHTSMAN, with First-class General Engineering knowledge REQUIRED.—Apply by letter, stating age, salary and experience to the TELEGRAPH CONSTRUCTION and MAINTENANCE CO., Enderby's Wharf, East Greenwich. P212 A

STRUCTURAL DRAUGHTSMAN WANTED AT ONCE; man with a little designing and estimating experience preferred. State age, experience, and salary required.—Apply in confidence to the MANAGER, Redpath, Brown and Co., Ltd., 19, Waterloo-street, Glasgow, by letter only. P198 A

SITUATIONS WANTED

AN ENGINEER (29), Well Educated, Good Draughtsman, trained with large engineering firm in workshops and on design, SEEKS NEW APPOINTMENT in responsible capacity, or good prospects with large firm preferably in the Midlands. Experienced, factory erection, extensions, maintenance and efficiency, general plant and power-house lay-outs, power distribution. Good knowledge rubber industry.—Address, J. J. SMITH, 186, Kew-road, Richmond, Surrey. P222 B

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ENGINEER and WORKS MANAGER AT LIBERTY. Thoroughly up-to-date methods of production, organisation of works and staff, reduction and allocation of costs.—Address, P231, The Engineer Office. P231 B

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PUMPING STATION ENGINEER (Married), SEEKS POSITION. Experience with oil and steam-driven plants, erections and testing, main laying, &c. Prefers North Midland district.—Address, P223, The Engineer Office. P223 B

TRANSLATOR, German, French, Spanish, some Norwegian, extensive commercial and engineering experience, University Degree, SEEKS ENGAGEMENT, preferably with consulting engineer.—Box 201, W. H. Young, 177-8, Fleet-street, London, E.C. 4. P218 B

DRAUGHTSMAN, JUN. (21), Mech., any Branch, SEEKS SIT.; leaving tech. college; gain further exp.; London dist.; low wages; ex. refs.; specimen of work available.—47, Stanton-road, Wimbledon. P211 B

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PARTNERSHIPS

WANTED, in North Midlands Area, HALF-SHARE in General and Electrical Engineering Repairs Business, including Hydraulic Driving Specialities. Invest £200.—Apply, T. ROPER and CO., Bromsgrove. P214 C

CAPITAL, PARTNERSHIPS, DIRECTORSHIPS.—Any genuine business hampered through lack of capital can be assisted. Arrangements made for formation of Private Limited Liability Company. Underwriting, Mortgages, and any sound proposition entertained.—Write, "C. P. D.," c/o Shelley's, 11, Crooked-lane, E.C. 4. P220 C

AGENCIES

AGENTS or REPRESENTATIVES REQUIRED. No samples to carry; no competition; restricted trades and areas.—Apply, F. S., 171 Maida Vale, W. 9. P210 D

APPLICATIONS are INVITED from Engineers and Engineering Firms with knowledge of Steam Raising, wishing to UNDERTAKE an AGENCY for a Complete Plant for Feed-water Treatment. Vacancies in London, Midland Counties, and Yorkshire.—Letters, giving fullest particulars, should be addressed to—P232, The Engineer Office. P232 D

CHARTERED MECHANICAL ENGINEER. Having a long-established connection, WISHES to get in touch with progressive firms desiring efficient TECHNICAL and SALES REPRESENTATION in Manchester and District.—Address, 242, Royal Exchange, Manchester. P226 D

ENGINEER-SALESMAN (40), Connection Trade and large industrial concerns in Yorkshire and district, DESIRES REPRESENTATION of Manufacturers of a high-grade speciality.—Address, P196, The Engineer Office. P196 D

MANUFACTURERS have OPENING for Well-established AGENTS with connections amongst Steam Users in principal commercial centres where not already represented. A splendid proposition.—SMITH'S (NON-INCRUSTA), Ltd., Tennyson-place, Bradford, Yorks. 5682* D

EDUCATIONAL

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Examinations of the
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INST. OF STRUCTURAL ENGRS.,
UNIVERSITY OF LONDON, &c.,
are personally conducted by
Mr. Trevor W. Phillips,
B.Sc., Honours, Engineering, London University, Assoc. M. Inst. C.E., A.M.I. Struct. E., M.R.S.I., F.R.S.A., Chartered Civil Engineer, &c.

For full particulars and advice apply to:—36, DALE-STREET, LIVERPOOL (Tel., Bank 1118). LONDON OFFICE: 65, CHANCERY-LANE, W.C. 2. Ex.

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THE TECHNOLOGICAL INSTITUTE OF GREAT BRITAIN (*Established* 1917).
76, Temple Bar House, London, E.C. 4.

MISCELLANEOUS

WANTED: "UNIVERSAL TRANSMISSION —ORDNANCE APPLICATIONS," QUARTO, 50 PP., PRINTED BY WATERLOW BROS. & LAYTON, 1910.—GEO. HARDING, 64, GREAT RUSSELL-STREET, W.C. 1. P217 I

ANYONE REQUIRING FIRST CALL on OUTPUT of excellent IRONFOUNDRY, 40 miles from London, quick delivery and low prices, SHOULD WRITE R. CASTELL and CO., 42, Tavistock-square, W.C. 1. P201 I

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A.M.I. Mech. E.—95%
A.M.I.E.E.—100%

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For continuation of Small Advertisements see page 4.

COMPANY MEETING

BRITISH DARDELET THREADLOCK (D.D.G.) CORPORATION.

The meeting of the British Dardelet Threadlock (D.D.G.) Corporation, Ltd., was held on Tuesday, the 2nd September, at Winchester House, Old Broad-street, E.C.

Mr. Eustace C. Quilter (the chairman), who presided, said that the capital expenditure set out in the balance sheet at approximately £113,000 had put the company in a position to manufacture a large output of bolts and nuts of various types with ample land for future extensions, while their investments in Government securities and the cash in hand, totalling £125,796, gave them ample working capital; interest on investments and deposits had slightly exceeded general expenditure to date, so that the profit and loss account showed a nominal profit.

After considering the position carefully, the board had decided to manufacture themselves, as it was clear that the alternative method of licensing other manufacturers was at the moment impractical and undesirable. Once the Dardelet screw thread was established, however, the question of licensing would receive full attention. A suitable site had been secured, the first section of the factory had been erected, equipped, and production had commenced in the March of this year. The necessary extension and the plant to deal with the manufacture of "black" and cold-headed bolts was completed last May.

The directors were completely satisfied that the Dardelet bolt and nut could be accurately and economically manufactured in large quantities on the same machines and by the same methods as those used for ordinary screw threads. Tensile tests carried out on steel bars, one end threaded with Dardelet and the other with British Standard Whitworth thread, showed that the Whitworth thread broke in all cases, whereas the Dardelet thread showed no visible signs of failure. The same occurred in tests against the British Standard fine thread. Under tensile impact test the Dardelet was proved to be over 70 per cent. stronger than the Whitworth, and under torsional test 50 per cent. stronger, while the robustness of the profile of the Dardelet thread did away with the chipping and burring experienced in the case of the fine V threads. Moreover, it was proved that Dardelet bolts and nuts could be assembled more rapidly. In addition to those strong advantages, there was the fact that the profile of the thread provided a perfect lack at any point.

The company's sales campaign was commenced in May last, and it was satisfactory to be able to state that several Government departments and over 200 engineering firms, many of them of the highest standing, were carrying out tests on samples. Generally, the directors were satisfied with the progress so far made, and as to the Overseas rights in Canada, South Africa, India, Australia, and New Zealand, firms of the highest standing had taken up the company's representation.

Having regard to the novelty of the invention and the prevailing general depression, your directors are satisfied with the progress so far made. There are also favourable indications of the business to be done when the company is in production of black bolts, railway fish-bolts, and other types in general use, by the end of the present year, pending which special arrangements have been made for supplying railway companies and others here and in the Colonies, and also South America, with samples for test, supplied to their requirements.

I am informed that sales in France are satisfactory in proportion to their present scale of manufacture, and that the Belgian company developing the Dardelet rights is doing satisfactory business.

As regards patents, all material patents, both original and those subsequently taken out or applied for, have been protected—or have been applied for—in this country, the Dominions, and principal Colonies, and all the requirements with regard thereto complied with.

The report and accounts were unanimously adopted, and at an extraordinary general meeting which followed, the Articles of Association were modified to conform with the new arrangement with the French undertaking, and the title of the company was changed to British Dardelet Threadlock, Ltd.

A Seven-Day Journal

British Destroyers to be Sold.

THE announcement is made that the Admiralty has decided to strike the names off the effective list of the Royal Navy and to prepare for sale, the destroyers "Simoon," "Sparrowhawk," "Shark," "Seabear," and "Tactician," which are now serving with the Maintenance Reserve at Rosyth. The vessels belong to the Admiralty "8" class of destroyers, and they were laid down in 1917, being built to the designs of Sir E. H. Tennyson d'Eyncourt, a former Director of Naval Construction. They have a displacement of 1075 tons, with a length of 276ft. overall, a beam of 26ft. 9in., and a mean draught of 10ft. 10in. The propelling machinery comprises twin-screw Brown-Curtis geared turbines, with oil-fired Yarrow boilers, and the designed output of the machinery is 27,000 S.H.P., corresponding to a speed of about 36 knots. The armament includes three 4in. guns, light guns, and torpedo tubes. The "Simoon," "Sparrowhawk," and "Tactician" are to be towed to Sheerness Dockyard and the "Shark" and "Seabear" to Chatham Dockyard. The "Simoon" and "Seabear" were built by John Brown and Co., Ltd., at Clydebank; the "Tactician" by William Beardmore and Co., Ltd., at Dalmuir; and the "Shark" and "Sparrowhawk" by Swan, Hunter and Wigham Richardson, Ltd., at Wallsend—practically all the ships being begun in 1917 and completed the following year. The vessels will be replaced in the Maintenance Reserve by destroyers of the "W" class, which were lately withdrawn from the Mediterranean Third Destroyer Flotilla, having been relieved by the new "Acasta" class of ships.

The New Dunston Power Station.

THE Newcastle-upon-Tyne Electric Supply Company, Ltd., has placed with C. A. Parsons and Co., Ltd., of Heaton Works, Newcastle-upon-Tyne, an order for three 50,000-kilowatt turbo-alternators, for a new power station at Dunston which the company is providing in connection with the scheme for the standardisation of frequency in the North-East Coast area, which is being carried out under the Electricity (Supply) Act of 1926. The turbines will be of the two-cylinder tandem-compound reaction type, and will run at a speed of 1500 r.p.m. They are to operate on an initial steam pressure of 600 lb. per square inch at a temperature of 800 deg. Fah. Interstage reheating to a temperature of 800 deg. Fah. is to be incorporated into the design. Whilst the maximum continuous rating of each of the three sets will be 50,000 kW, the plant is to be so designed that maximum economy over a wide range of loads is assured. The alternators will be of the totally enclosed type and are to be directly coupled along with their exciters to the turbines. Each alternator will have a designed output of 50,000 kW or 62,500 kVA, 13,500 volts, 2670 ampères, at 0·8 power factor and 50 cycles. The alternators are to be coupled to the power network through step-up transformers. The new sets will, we understand, be amongst the largest which have recently been ordered for service in this country, and with the exception of the alternators at Brimsdown power station, which generate at 33,000 volts they will work at the highest voltage of any sets in Great Britain. The consulting engineers for the new power station are Messrs. Merz and McLellan, of Newcastle-upon-Tyne and London.

London Tube Improvements.

THE London Underground Railway Company has placed the contract for the construction of the new tunnel section of the Piccadilly tube railway extension to Southgate with Messrs. Charles Brand and Son, civil engineering contractors, of Millbank House, Wood-street, London, S.W. The new section of railway referred to extends from Finsbury Park northwards, to Maidstone-road, Southgate, a distance of about four and a-half miles. Eventually another section above ground will be run from Southgate to Cockfosters, a distance of about three miles, but the contract for this section has as yet not been placed. In connection with the tube extensions on the Piccadilly line, and the reconstruction of certain other tube stations in London, no less than fifty new escalators will be required. The order for these escalators has been placed with Waygood Otis, Ltd., of London, and it is understood that a new and improved design will be supplied. All the parts will be made in London, and British materials will be used. The contract is stated to be the largest of its kind which has yet been placed.

The Science Museum.

THE retirement of Mr. H. W. Dickinson, under the age limit, from the position of Keeper in the Engineering Division of the Science Museum, South Kensington, on Monday last will be regretted by all those who have had dealings, as donors, or visitors, or researchers, with him during the many years in which he has been on the staff of the Museum. Mr. Dickinson has brought to his work a profound knowledge of the history of engineering, a retentive memory, great enthusiasm, an inexhaustible willingness to help, unfailing courtesy and a ready humour. He is the son of an engineer, an engineer by education and training, and a member of the Institution of Mechanical Engineers. He was born just sixty years ago, was educated at the Manchester Grammar School and Owens College, and trained at Beardmore's and elsewhere. In 1895, he joined the staff of the Science Museum, and rose to be Senior Keeper and Keeper of the Engineering Collections, and since 1914 has been Secretary to the Advisory Council. During the war, he acted as secretary to the committee for the examination of inventions, under the Ministry of Munitions, and he is honorary secretary to the Second International Congress on the History of Science and Technology, which will meet in London next year. Besides work done in the preparation of Museum catalogues, he is the author of the most comprehensive life of Fulton, and with Mr. Rhys Jenkins, of the Memorial Biography of James Watt. He was one of the original founders of the Newcomen Society, and has been its honorary secretary from the first. It is to be hoped that Mr. Dickinson will employ some of his leisure in writing and lecturing upon subjects connected with the history of engineering and general technology.

Salving the P. & O. Liner "Egypt."

AT the beginning of the week, after careful searching, divers from the Italian salvage steamer "Artiglio" located the wreck of the P. and O. liner "Egypt," which, it will be recalled, was sunk seven years ago off the coast of Brittany. The ship, which is lying on an even keel in 66 fathoms of water, was recognised by her two funnels and a lifeboat. As soon as the hull was identified, many descents were made to it and within 72 hours one of the ship's hydraulic cranes was blasted free, and was raised to the surface. The main object of the salvage work is the possible recovery of the gold ingots which it is believed are stored in the strong room situated in front of the forward funnel on the orlop deck. In order to reach this room, it will be necessary to cut or blast through four decks, and preliminary arrangements for carrying out this operation are now in hand. Although there is every prospect of a continued fine spell of weather, with favourable tides, for some days it is recognised that the work may take some time, and that it is well within the bounds of possibility that it will become necessary to mark the site of the wreck by means of buoys, and to resume the salvage operations after the winter season has passed.

The Coal Mining Industry in 1929.

THE recently issued report of the Secretary of Mines for 1929, which appears with that of the Chief Inspector of Mines for the same period, lays stress on the increased demand for coal which last year was evident, not alone in our own country, but throughout the world, with, as a consequence, a record world output. The improvement which was discoverable in our own coal trade towards the end of 1928, gathered strength in 1929, and not since 1923 has there been such a spell of marked activity. The total output for 1929 was 258,000,000 tons, or about 20,500,000 larger than that of the preceding year. The increases were most clearly marked in the exporting districts. Compared with the output for the preceding year the increases in Scotland were 1·8 million less, or 5·6 per cent.; 4·8 million tons, or 11·2 per cent. for South Wales and Monmouth, and 5·9 million tons, or 12·3 per cent. for Northumberland and Durham. The output of anthracite coal reached the record figure of 6·4 million tons. An interesting feature was the increase in coastwise cargo coal traffic. In 1924 this tonnage was about 14,750,000, and in 1929 it reached 19,000,000, a figure slightly in excess of the tonnage of 1913. The Chief Inspector's report indicates that the death-rate among employees above and below ground was 1·11 per thousand persons, against 1·0 for 1929. In all, 1076 persons were killed and 175,899 injured, bringing the figures for the last ten years to 10,440 and 1,576,890 respectively. It is noted that in this decade the injuries resulting from explosions were insignificant in comparison with those arising from falls of ground and from haulage accidents. The report states that the efficiency of steel arches for the support of roads is made more strikingly apparent by the fact that not a single accident from falls in any part of a road supported by such arches was reported to the Divisional Inspectors.

Welland Ship Canal Opening Postponed.

THE official opening of the Welland Ship Canal, which was originally fixed for Monday last, September 1st, has been unavoidably postponed and is not likely to take place before next spring. In carrying out the excavation work near to Welland the contractors unexpectedly encountered, about one and a-half miles away from the town, large masses of very hard material. It will probably be towards the middle of September, we are informed, before the summit level of the canal can be dredged out to the proper depth and section necessary to accommodate large merchant ships. The opening ceremony has, therefore, been put off until 1931. The new canal, which, it may be recalled, has already been described in our issues of August 19th, 1927, and May 10th, 1929. It connects the lakes Erie and Ontario across the Niagara peninsula, a distance of 25 miles. There are seven locks, each with a uniform lift of 46ft. 6in. The canal reaches are 200ft. wide at the 25ft. depth and 310ft. wide at the water line. In the lock chambers the culverts have so been constructed that the locks can be filled or emptied in 8 minutes, thus enabling a loaded ship to pass through the canal in 8 minutes, or a little more than half the shortest time hitherto taken.

A Proposed Humber Bridge.

ON Monday last, September 1st, an adjourned conference of the Hull Corporation and local administrative authorities was held at the Hull Guildhall to consider the proposed scheme to construct a bridge over the river Humber estuary, at an estimated cost of £1,750,000. The Government, through the Ministry of Transport, has expressed its willingness to give a grant of 75 per cent. of the amount, and the Hull authorities have decided to provide £200,000. The Lindsey County Council of Lincolnshire has promised to contribute a sum of £30,000, exclusive of £10,000 offered by the Barton-on-Humber Urban District Council, and other smaller bodies have made conditional offers of sums of £1000 and £2000. On the other hand, the East Riding County Council has declined to support the scheme, on the grounds that only Hull would benefit by the bridge, and not the rural areas under the administration of the Council. Several smaller authorities are also standing out, on account of the action of the East Riding Council. The outcome of the meeting of Monday last, when the questions of finance, maintenance and the construction of convenient approaches were discussed, was considered to be disappointing, and a deputation from the Hull Corporation, along with other local authorities who also have an interest in the scheme, is to wait on the Minister of Transport and place the position now created before him.

Preparing for the New Cunarder.

ON Tuesday, September 2nd, the Clyde Navigation Trustees announced that they had allocated the sum of £34,000 for the widening and deepening of the Clyde in order to afford safe launching facilities at Clydebank and a subsequent clear passage down the river when the new Cunarder is completed. It is understood that the sum above referred to is to cover the expenditure for the preliminary work which will take place this year, and it is most likely that the complete operation will cost about £75,000. Although Mr. J. J. Lawson, the Parliamentary Secretary to the Ministry of Labour, has repudiated the statement attributed to him regarding the decision to place the order for a second Cunarder on the Tyne, the Cunard Steamship Company, Ltd., in an official statement on the question of the second ship, says that it has nothing further to add to its last statement on the matter of insurance. It points out that before any definite announcement can be made with regard to a second liner, important questions relating to financial arrangements, planning and design have to be decided, which cannot be done in any haste.

The Mid-Scotland Canal Scheme.

THE Committee which was appointed by the Ministry of Transport, under the chairmanship of Sir Sidney Chapman, in order to consider the various schemes put forward for a mid-Scotland canal, has reported against the project. The findings of the Committee have been published as a White Paper. The schemes investigated, included the direct route, which follows approximately the line of the existing Forth and Clyde Canal, and also the Loch Lomond route *vid* Stirling and the Forth valley into Loch Lomond, and thence into Loch Long at Arrochar, or, alternatively, by way of the Leven Valley into the Clyde at Dumbarton. The Committee finds that the probable cost of constructing such a canal would most likely exceed considerably the sum of £50,000,000, while the maintenance of the canal would require not less than £150,000 a year. The Committee does not see any possibility of a financial return which would attract private enterprise even with a large Government grant. Further, from the point of view of the facilities offered to shipping, it concludes that the probable revenue might not be sufficient to cover the working expenses and maintenance cost, let alone making any return on the capital. Further, there does not seem to be any prospect of development in the canal area, which might justify the expenditure. On the constructional side, having specially in mind the provision of employment relief, it is pointed out that the work could not be begun for at least three or four years, and that the peak of employment would not be reached until five or eight years after commencing the operations, which would be about half-way through the constructional period. A detailed survey of the direct route, in order to ascertain the formation of the strata through which the excavations would have to be made, would, it is estimated, cost from £30,000 to £40,000, and this information would be necessary before the actual cost of construction could be assessed, but in the view of the Committee it is doubtful whether even this expenditure should be incurred.

Super-pressure Boiler at Bradford Power Station.

No. I.

WHEN the city of Bradford, on the advice of Mr. Thomas Roles, its electrical engineer, decided to use steam at a pressure of 1100 lb. per square inch and a temperature of 800 deg. Fah. for the extensions of the Valley-road power station, it took a step of great significance to British central station practice. Up to that time the highest steam pressure in any power station in the country was the 475 lb. adopted by the Newcastle Electric Supply Company for the North Tees plant in 1917. Considerable advances have since been made, notably by Imperial Chemical Industries, which have now boilers working at 815 lb., by the London Power Company, which will employ a pressure of 600 lb. per square inch for the new Battersea station, and by the Ford Motor Company, Ltd., which will work at 1250 lb., but there is as yet nothing in existence or in sight to challenge the supremacy of Bradford among British power stations in the matter of steam pressure. There are, of course, higher pressures in America, 1200 lb. and over being adopted in at least half a dozen central stations in the United States, but in none of them, so far as we are aware, is the temperature of the steam as high as at Bradford. On the Continent also there are several examples of very high-pressure steam, associated sometimes with very high temperatures, so that, while Bradford cannot claim anything like a world record, its enterprise, nevertheless, restores Great Britain to her place amongst the pioneers of power station practice.

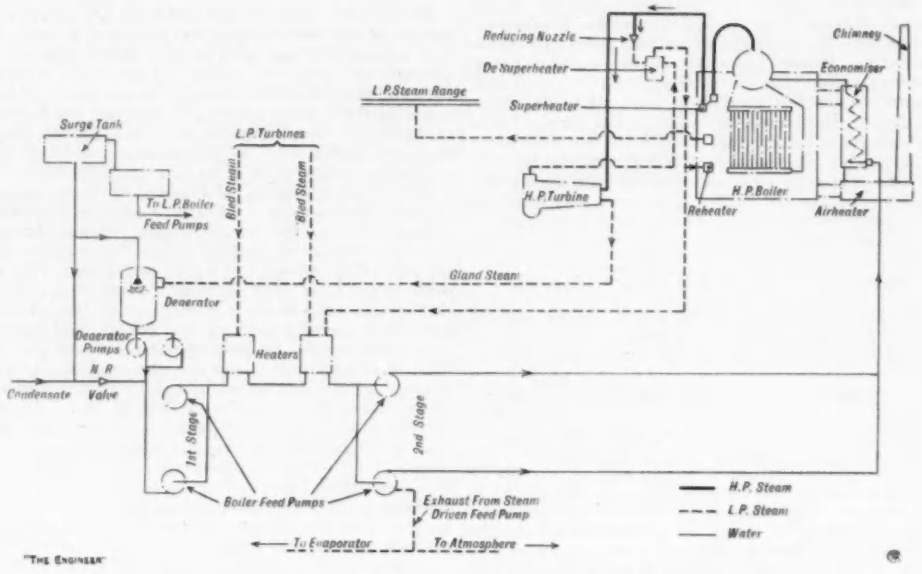


FIG. 1—DIAGRAM OF STEAM AND FEED-WATER PIPING

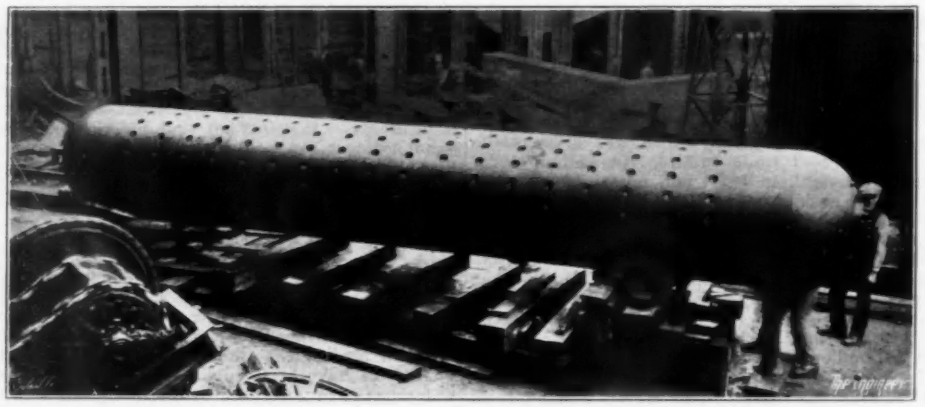


FIG. 2—FORGED STEEL HIGH-PRESSURE BOILER DRUM READY FOR ERECTION

To understand the reasons which determined Mr. Roles to adopt steam conditions so far in advance of anything in the country, it is necessary to consider the circumstances which prevailed in the Valley-road station. When the latter was designed in 1896 the boiler pressure chosen was 200 lb. per square inch gauge and in 1900 superheaters were installed which increased the steam temperature to 488 deg. Fah. In those days such figures were well abreast of current practice, and the pressure conditions were naturally which was then current practice for new plants, would have brought about operating difficulties, probably at least as great as the increase of efficiency which might have been obtained. The alternative was to go up to such a pressure as to allow the new turbine plant to exhaust at a pressure equal to that of the steam at the inlet of the existing turbines. In other words, the idea was to "compound" the old turbines made available for higher pressures, by the addition of a "McNaught" cylinder, ahead of the low-pressure cylinder.

The scheme of compounding the station in this way had manifest advantages. Its efficiency would be by the addition of a high-pressure cylinder ahead of them much as, in the last century, the old beam engines in Lancashire and Yorkshire were greatly increased in power and efficiency, besides being augmented and its power increased at the least possible cost, for no more condensing plant would be needed, and the old turbines would be given a new lease of life by employing them under the new conditions. Compounding, however, would only be worth while if the new boiler pressure were sufficiently high to enable the new turbines to develop an adequate amount of power when exhausting at the original range pressure of the station. A further and more important reason for the choice of a very high initial pressure was, of course, the thermodynamic gain involved. By selecting a gauge pressure of 1100 lb. and a temperature of 800 deg. Fah., the adiabatic heat drop of steam expanding down to a condenser vacuum of 28½in. was increased from 432·0 B.Th.U. to 538 B.Th.U. per pound, as compared with that of steam having a pressure of 200lb. and 700 deg. Fah. total temperature. The theoretical consumption of the engine-room, assuming the Rankine cycle to be followed, was therefore reduced from 7·9 lb. to 6·34 lb. of steam per kilowatt-hour, and the thermal efficiency increased, on the same assumption, from 34·6 to 40·4 per cent. The practice of progressively heating the feed water by means of partly expanded steam withdrawn from the turbines, which is now always adopted, no doubt renders the Rankine cycle a somewhat inaccurate

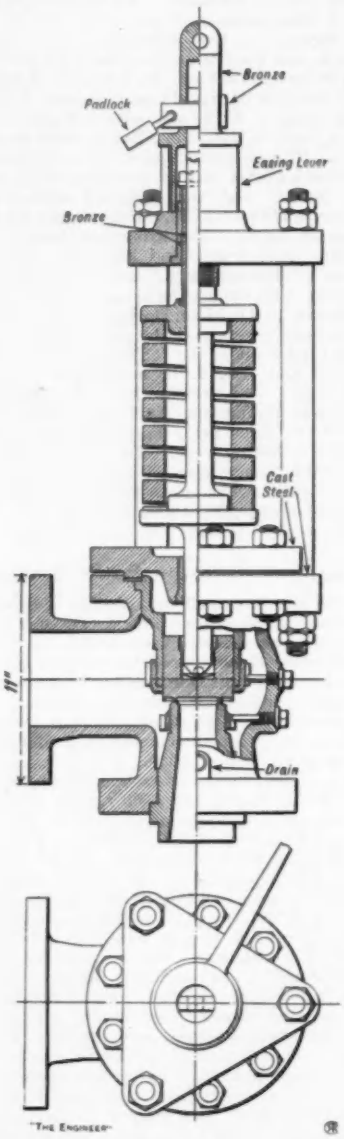


FIG. 4—2IN. SPRING SAFETY VALVE

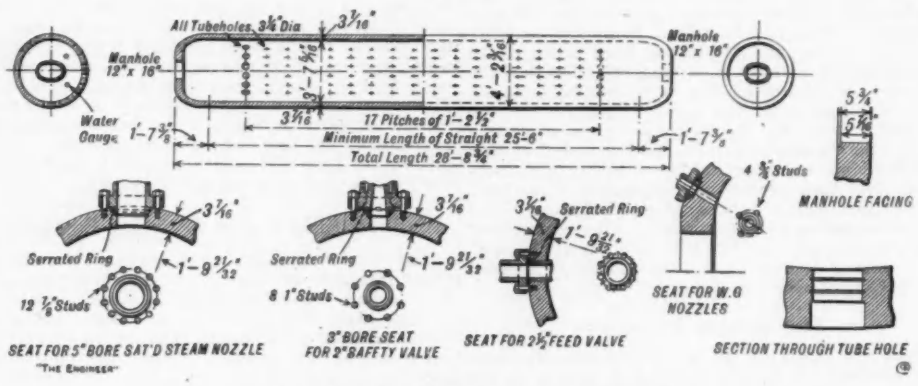


FIG. 3—DETAILS OF DRUM AND CONNECTIONS

basis of comparison; but, however one makes the calculation, the gain due to the higher pressure and temperature is of the order indicated. It may, moreover, be mentioned that experience has shown that the theoretical gain is actually realised in practice, this fact having been testified to by Mr. Moultrop in connection with the Edgar station in America, where "compounding," much on the lines of Bradford, has been in operation for some time. There is indeed no doubt that the installation of high-pressure plant, to be operated in series with existing plant, is the natural course of evolution of a power station possessing good machinery, but handicapped as regards efficiency by the low boiler pressure originally adopted. To Bradford falls the honour of being the first British station to take the step indicated and of embodying the principle in a manner which will at least bear comparison with the best examples of power station practice abroad.

The general arrangement of the high-pressure boiler unit at Bradford is illustrated on the two-page plate issued as a Supplement to the present number of THE ENGINEER, and general views taken during the erection of the plant are reproduced in Figs. 9 to 11 on page 254. From Fig. 9 it may be gathered that the new unit stands in a small house of its own constructed for the purpose, independently of the original boiler-house. The space available was none too great, but so well has it been taken advantage of that accessibility to every part of the plant has been attained in a most commendable degree. In contrast to the conditions so often met with, it is really pleasant to inspect the unit, as an electric lift has been installed from ash basement to fan floor with stops at intermediate galleries and broad comfortable staircases lead to the various roomy platforms at different levels and terminate in a spacious floor at the top, where the fans are situated. An idea of the arrangement can be gathered from the drawing of the front elevation, given in the Supplement, though it by no means conveys an adequate impression of the roominess and convenience of the staging and stairs.

The duty of the boiler is to generate normally 75,000 lb. of steam per hour at a pressure of 1100 lb. per square inch, and a temperature of 800 deg. Fah., though an output of 94,000 lb. of steam per hour can be continuously maintained. This steam having done work in the high-pressure turbine is exhausted at a pressure of 205 lb. per square inch gauge, and with its temperature reduced to 510 deg. Fah., to be re-superheated to 755 deg. Fah. by a reheater built into the boiler. The latter, as will be seen from the illustrations, is fired by a single chain grate stoker, which is the largest in the country. The furnace gases pass upwards through the whole length of the lower rows of boiler tubes; they then traverse the superheater and the re-superheater in series, and make three passes through the remainder of the boiler tubes. On leaving the boiler proper, they descend through the economiser, placed where it is on account of exigencies of space, and then re-ascend through the tubular air heater to the induced draught fan grit collector and chimney.

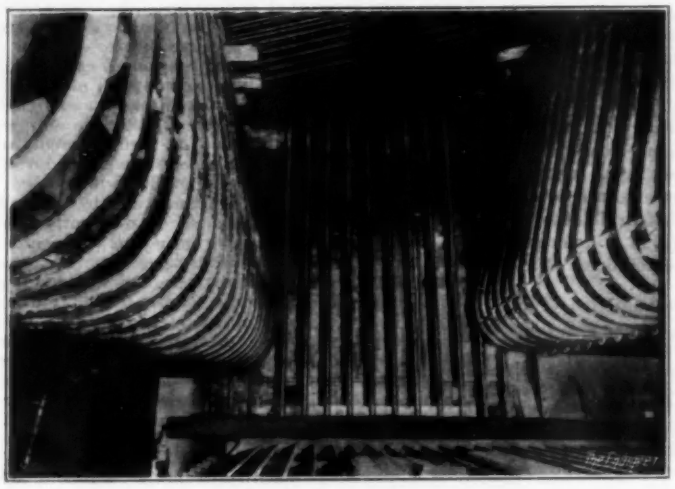


FIG. 5—WATER COOLING TUBES OF FURNACE

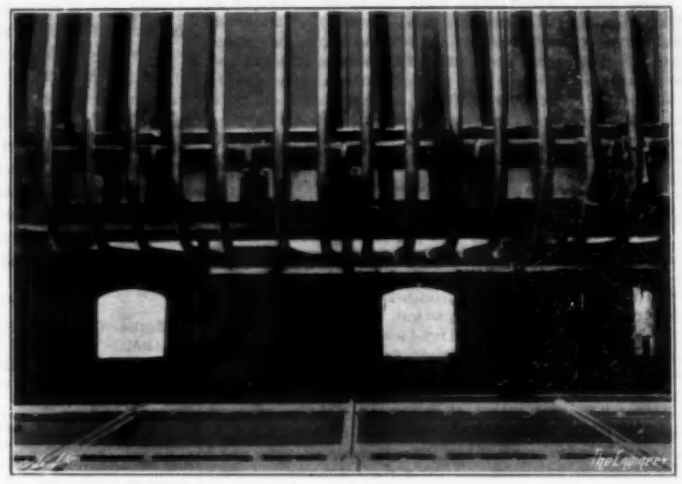


FIG. 6—WATER TUBES FOR COOLING BACK ARCH

The leading particulars of the plant are given concisely in Table I. below :—

TABLE I.

Boiler pressure, gauge, lb. per sq. in.	1,100
Stop valve temperature, deg. Fah.	800
Maximum continuous evaporation, lb. per hour	94,000
Boiler heating surface, sq. ft.	8,365
Water wall heating surface, sq. ft.	810
Aggregate water heating surface, sq. ft.	9,175
Superheater heating surface, sq. ft.	2,013
Reheater heating surface, sq. ft.	1,585
Economiser heating surface, sq. ft.	8,412
Air heating surface, sq. ft.	16,400
Grate area, sq. ft.	386
Width of grate, feet	21·4
Volume of combustion chamber, cu. ft.	3,700
Quantity of steam reheated, lb. per hour	72,000
Pressure of reheated steam, gauge, lb. per sq. in.	205
Temperature of reheated steam, deg. Fah.	755
Temperature of steam entering reheater, deg. Fah.	510
Feed water at de-aerator inlet, deg. Fah.	160
Feed water at de-aerator outlet, deg. Fah.	190
Feed water entering economiser, deg. Fah.	300
Steam pressure, gauge, H.P. feed heater, lb. per sq. in.	110 to 205
Steam pressure, gauge, L.P. feed heater, lb. per sq. in.	16
Flue gas temperature, boiler outlet, deg. Fah.	700
Flue gas temperature, economiser outlet, deg. Fah.	400
Flue gas temperature, air heater outlet, deg. Fah.	255

The arrangement of the boiler with relation to the turbines and auxiliary plant will be understood by reference to the diagram reproduced in Fig. 1. The high-pressure steam, after leaving the superheater, passes normally direct to the high-pressure turbine, from which it is exhausted to a de-superheater at a pressure of about 200 lb. per square inch. The object of the de-superheater is automatically to control the temperature of the steam before its admission to the reheater, and so to enable the latter to deliver it, after reheating, at a constant temperature of 755 deg. Fah. or at lower temperatures suitable for the older turbines to the low-pressure mains, regardless of the temperature of discharge from the high-pressure turbine. Should the latter not be in service for any reason, the boiler can still be used for the purposes of the station, as, in such a case, the high-pressure steam can be delivered direct to the de-superheater through a pressure-reducing nozzle and its condition as regards pressure and temperature made suitable for its passage through the reheater.

The condensate from the normal pressure turbines passes through a surge tank from which the feed water supply for the high-pressure boiler unit is drawn. This supply is first passed through a flash-type surface de-aerator fitted with dual extraction pumps, and these extraction pumps deliver the treated water direct to the main boiler feed pump suction line at a pressure of 25 lbs. per square inch gauge. In parallel with the de-aerated feed system is a by-pass feed line, in which is inserted a non-return valve so placed that, should one of the de-aerator extraction pumps fail whilst in service, the non-return valve opens and by-passes the feed water direct to the boiler feed pump suction line and thence to the economiser. The boiler feed pumps are in duplicate, and are of the double-casing type with two-stage progressive feed water heaters in series between the low-pressure and high-pressure casings.

THE BOILER PROPER.

In its general lines, the boiler represents what has come to be known as the cross-drum marine type, but the wide interdeck space required to accommodate the superheater and reheater, and particularly the incorporating of extra heating surface by water cooling the furnace, result in proportions somewhat different from those met with in more ordinary practice. The number of return tubes provided for the circulation of the water back to the drum is also noticeable. The drum itself is of solid steel forged from a single ingot. It is illustrated in Fig. 2, which shows it in the finished state delivered at Bradford and ready for erection. From the drawing reproduced in Fig. 3, it will be seen that the drum has an overall length of 28ft. 8¾in., with an inside diameter of 3ft. 7⅛in. and a wall thickness of 3 7/16in. At the ends the metal is 5¾in. thick, and in each end is an elliptical manhole for access to the interior. It is pierced with two longitudinal rows of holes for the downtake tubes and six rows for the return tubes, all tube-holes being 3¼in. diameter. The holding of tubes in so thick a drum to withstand a working pressure of 1100 lb. per square inch is a matter requiring consideration. The plan adopted by Messrs. Babcock and Wilcox and found

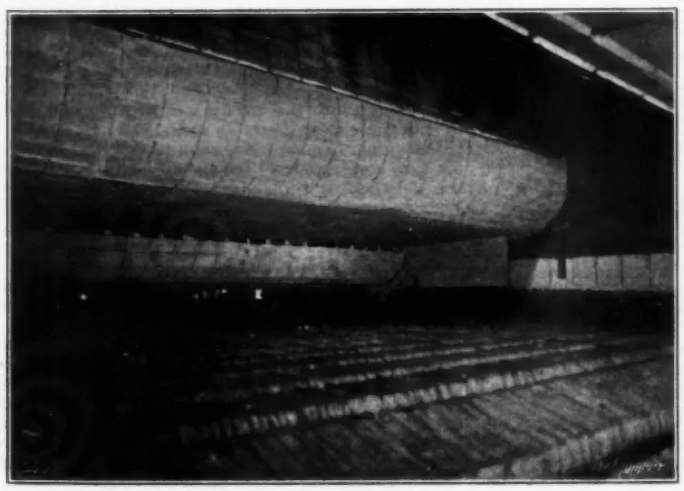


FIG. 7—VIEW OF FRONT ARCH FROM INSIDE FURNACE

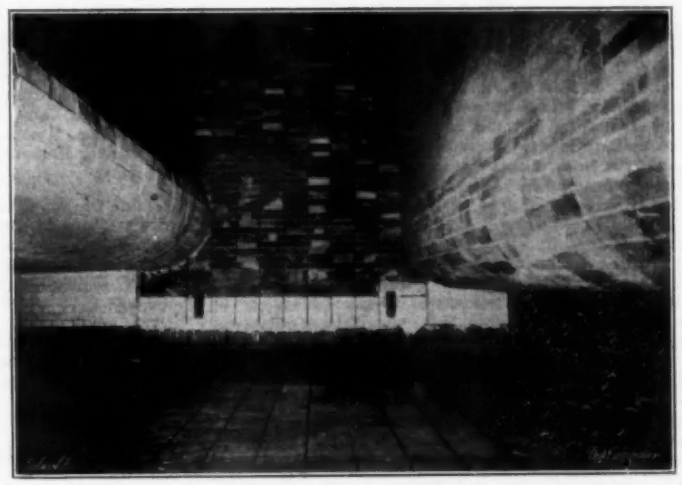


FIG. 8—GENERAL VIEW OF INTERIOR OF FURNACE

entirely satisfactory is indicated in Fig. 3. The tube-holes are slightly counterbored from the outside so as to reduce the actual holding surface of the tubes to a length equal to about half the thickness of the drum wall, thus ensuring an adequate contact pressure being developed by the expansion of the tubes. The holding surface of the tube-holes is divided into three equal portions by cannelures, into which the metal of the tube is forced by the expanding operation, so as to afford a mechanical hold against axial displacement. The inner edge of the hole is also slightly chamfered to give a further hold to the belled end of the tube.

The walls of the drum have, of course, also to be bored for the attachment of the steam pipe, the four safety valves, the two feed valves and the water-gauge and other fittings. The joints for these attachments are, in all cases, made on the same principle, namely, by the use of a mild steel joint ring serrated on both sides and clamped between the fitting and the base of a counterbored recess in the drum wall. The studs used for holding the fittings are turned down on the plain part to a diameter no greater than that at the bottom of the threads to avoid concentration of stress where the threaded portions end.

The design of one of the boiler safety valves, all of which were supplied by Dewrance and Co., Ltd., is illustrated in Fig. 4. The steam enters the valve by a passage-way of 3½in. diameter, which is tapered down to a short parallel portion 2in. diameter before the seating is reached. The latter is quite flat and only about ¼in. wide, so that an intensive pressure is exercised by the loading spring. The metal of the valve and seat-piece adjacent to the seating itself is shaped in such a way that the valve has a "pop" action, lifting suddenly when the steam pressure reaches the designed value, remaining well open until the pressure has dropped by a definite amount and then closing suddenly and completely. Both valve and seating are made of nickel alloy, the body of the valve and the cover being of cast steel. The design of the safety valves for the superheater and the economiser is exactly similar, except that in these cases the 4in. diameter spigot of the nickel alloy seating tube is omitted.

The water-gauges are connected to each end of the boiler-drum by means of horizontal pipes, which bring the gauges themselves into convenient positions for observation from what may be called the third storey of the boiler. The gauge glass valves are provided with gearing and extended spindles so that complete control can be effected from the firing floor. It is, of course, much more necessary that observations of water level may be made at any moment by a man standing on the firing floor, some 40ft. 6in. below. This is made possible and, indeed, convenient, by means of a couple of periscopes, one serving each of the gauges. Each periscope consists of a rectangular tube of sheet steel, 12in. by 6in. inside and built up in sections to a total length of 35ft. 6in. between the centres of the inclined mirrors at the top and bottom. These mirrors are made of ⅛in. plate glass, silvered, and are large enough to enable the whole of the water column to be seen. The visibility of the water level is also increased by strongly illuminating the gauge glasses. Each periscope is fitted with an intermediate mirror, which can be swung into position at will, so as to intercept the descending rays and render the water level visible to a man standing on either of the intermediate platforms of the boiler.

The Furnace.

The general form and the nature of the construction of the furnace are well illustrated in the Supplement, though the photographs taken during erection and reproduced as Figs. 5 to 8 on page 245 perhaps give a more vivid impression. As will be seen, the furnace is entirely water cooled, tubes connected with the boiler system abstracting the heat from the side walls, the back and the arch with its front wall. The arrangement of the tubes before being bricked in is clearly shown in Fig. 5, a separate view of those for cooling the back arch being given in Fig. 6. General views of the interior of the finished furnace with the grate in position are shown in Figs. 7 and 8. The furnace is 21ft. 6¾in. wide from wall to wall inside, and about 7ft. across at the narrowest point between the ends of the arches. From this point it flares outwards, fore and aft, to attain a length practically equal to that of the boiler tubes where it meets them at about 16ft. above the level of the grate surface. The interior, which is reached by a door of comfortable size at the back, gives the impression of great roominess. It contains, as a matter of fact, 3700 cubic feet of space, or 0·403 cubic foot for every square foot of boiler heating surface, inclusive of the water walls. The water-tube surface in the front wall, ar h and rear wall has a combined area of 580 square feet, and in the two side walls an area of 230 square feet, making a total water-cooled furnace area of 810 square feet. Every care has been taken in the design to ensure perfect and smokeless combustion of the kind of fuel to be burnt, and provision has been made for the admission of secondary air to the surface of the coal at the end of the short igniting arch. This, of course, is in addition to the thorough control of the admission of primary air which is afforded by the compartment type stoker.

(To be continued.)

The General Electrification of France.

OUR contemporary, *Le Génie Civil*, gives, in its issue of August 23rd, an exceedingly interesting review of the present state of electrification in France. The article is from the pen of Monsieur J. Mathivet, Ingénieur en chef aux Mines de Nœux, who has also added a series of suggestions by which he maintains that the existing network of transmission lines might be considerably improved.

Monsieur Mathivet begins by recounting how that the French Electrical Engineers, as soon as the War was over, set themselves resolutely to supply, to the principal industrial centres, the electrical energy which was considered indispensable to their reconstitution. First of all, the then-existing heat and hydro-electric stations had to be reconditioned and new generating stations had to be built in the most advantageous positions, taking everything into consideration. Then it was necessary to link up all these centres of energy production by means of a homogeneous network of high-tension transmission lines.

Central Stations.

Monsieur Mathivet discusses the first portion of his theme under two headings:—"Central Stations" and "Network." He points out that the whole of the district south of Orleans, embracing the Pyrenees, the *Massif Central* and the Alps, is plentifully besprinkled with hydro-electric stations. He estimates the total capacity of all the existing hydro-electric stations in this area as being in the neighbourhood of 1,500,000 kW.

Turning, then, to heat stations, Monsieur Mathivet asserts that the progress made with them has been even greater and more rapid than that experienced with the hydro-electric stations. Among the directions in which progress has been most noteworthy he points to:—(*a*) The use of powdered coal; (*b*) the employment of high-pressure steam; (*c*) the re-heating of feed water by steam bled from the turbines; (*d*) the pre-heating of combustion air; (*e*) the cooling of alternators on the closed circuit system; and (*f*) the use of high-tension direct current.

The principal central generating stations in France are then arranged together in a table which we reproduce below:—

Principal Electric Generating Stations in France.

(*a*) *Hydro-Electric Stations.*

Centre Region: L'Isle Jourdain on the Vienne; Eguzon, on the Creuze; Tuilières on the Dordogne; and Coindre, on the Rhue, an affluent of the Dordogne.

Pyrenees: The stations erected by the Midi Railway Company (Eget, le Hourat, Miégebat, Artouste, &c.);

Alps: The combination of stations controlled by l'Energie électrique du Littoral Méditerranéen (La Brillanne, Sainte-Tulle, Ventavon, &c.); the Beaumont-Monteux station on the Isère; the Chancy-Pougny station on the Rhone; and the Kembs station on the Rhine, which is under construction.

(*b*) *Heat Stations.*

I.—Paris (Gennevilliers, Saint-Ouen, Saint-Denis, Issy, Ivry, Vitry.

II.—The Nord and Pas de Calais Coalfields (Chocques, Labuisière, Beuvry, Bully, Vendin, Eleu, Harnes, Dourges, Dechy, Lourches, Thiers, Saint-Saulve, Jeumont, Maubeuge).

III.—Lille, Rouen, Nantes, Bordeaux, Toulouse, Arles, Marseilles, Saint-Etienne, Lyons, Strasburg.

Adding the capacities of these heat stations to those of the stations in towns of secondary importance an installed capacity of 3,500,000 kW is arrived at. The combined capacities of the hydro-electric and thermal stations amount, therefore, to a total of 5,000,000 kW, which, Monsieur Mathivet remarks, "corresponds to 54 millions of kilowatt-hours per day, or 15 milliards of kilowatt-hours per year; that is to say, about 300 kWh per year per inhabitant." It must, however, not be fogotten, he continues, that:

Norway consumes 2500 kWh per year per inhabitant;
Canada consumes 1200 kWh per year per inhabitant;
Switzerland consumes 900 kWh per year per inhabitant;
The U.S.A. consumes 700 kWh per year per inhabitant;
Sweden consumes 600 kWh per year per inhabitant.

There is much to be done, therefore, he adds, before France attains even to the consumption of Switzerland and it is that which justifies the formation of the "magnificent national network," which he then proceeds to discuss.

Transmission Lines.

A primary point on which a decision had to be reached was whether the transmission of energy should be effected (*a*) with high-tension direct current, like that on the Thury system, between Moutiers and Lyons, or (*b*) by means of high-tension alternating current. As is generally known, the latter alternative was chosen. There were, however, obstacles in the way of its general adoption. In the Paris area alone three different periodicities—25, 42 and 50—were in use, so that the best periodicity to employ, universally, had to be decided, and 50 period current was chosen as being that which it is considered, will, most probably, be used throughout the Continent in future. Ever since 1920, therefore, all the new central stations—both Parisian and provincial—have been given that periodicity. The choice made it necessary, however, to replace or convert the motors then working in the Paris sector on 25 or 42 periods, and that was an operation of considerable magnitude, but it has been carried and, now all the motors in the metropolitan area operate at 50 periods. In fact, in the whole of France, there is only one isolated instance of the use of 25 period current, and that is the network of l'Energie électrique du Littoral Méditerranéen, which is being gradually converted.

It then remained to determine at what pressure or pressures the energy should be transmitted, and on that point there was by no means a concord of opinion. The reason for disagreement was, very naturally, that the distances through which the current had to be transmitted varied considerably. Furthermore, the technique of high-tension transmission had shown continuous evolution during the past ten years, and, in view of possible future developments, the French Electrical Engineers did not feel themselves justified, as has been done in this country, in choosing a single transmission voltage so that the whole country might be served by a homogeneous network of transmission lines.

The pressures eventually chosen were:—45,000, 70,000, 90,000, 120,000, 150,000 and 220,000 volts. With this range of voltages, it was, of course, necessary to provide exchange transformers and their accessories at points where lines of different voltages came together, which, as Monsieur Mathivet points out, naturally complicated matters.

The accompanying map, which is reproduced from the pages of our contemporary, shows, in addition to the positions of the existing heat and hydro-electric central stations, the transmission network which is already in operation. The various circuits are indicated by full lines and Monsieur Mathivet has shown by broken lines the further connections which, he urges, might usefully be made so as to make the national network still more complete than it is.

It is explained that the majority of the lines at present in service operate at 90,000 and 150,000 volts. On certain lines, however—for instance, the Coindre-Eguzon-Orleans-Paris line—a pressure of 220,000 volts is to be employed, and Monsieur Mathivet considers it to be quite possible that, in the near future, only two pressures—150,000 and 220,000 volts—will be used throughout the whole of France. Moreover, the French constructors of underground cables have been by no means idle during the past ten years, and the Compagnie des Câbles de Lyon has already constructed armoured underground cables, which can operate successfully at 150,000 volts, and is at the moment engaged on investigating the possibility of manufacturing cables to operate at 220,000 volts. Monsieur Mathivet evidently has no doubt that the next few years will witness the gradual replacement of overhead lines by underground cables, working at those two voltages, which, he remarks, "would greatly increase the security of operation of our national network; we should thenceforth be sheltered from storms, and the problem of the regulation of pressure on lines of great length would be completely solved." He does not, however, go into the question of what it would cost to gain these most desirable ends.

Discussing his map, Monsieur Mathivet then points out how comparatively few lines are required to make the network of transmission lines really complete. The western part of the country alone—especially Brittany—has, he remarks, been treated like a "poor relation." The country immediately round Paris, too, is but sparsely served, whereas below Orleans, in the neighbourhood of Nantes, Bordeaux, Pau, Toulouse, Marseilles and Lyons, all districts appear to be abundantly served.

He then makes a digression to remark how much better it would have been for Paris had the coalfields of the Nord and Pas du Calais been sufficiently recovered from the ravages of war to transmit energy to Paris from generating stations at the pit-heads, before energy was available from the hydro-electric plants in the south. The Metropolis would not then have had to rely on imported coal.

Reverting again to his map, Monsieur Mathivet states that a study of it will make it clear that the principal transmission arteries may be grouped into fifteen lines, five of them traversing the country from north to south and ten traversing it from west to east. Each of these fifteen arteries, with certain additions, might serve as a connecting link between different central stations in such fashion that any one of those stations might come to the aid, or take the place of other central stations in its vicinity.

The five north-south arteries are set out as follows:—

(1) Dunkirk, Beuvry, Bully, Amiens, Paris,

Orleans, Chailley, Eguzon, Coindre, La Mativie-Brommat, Albi, Toulouse, Auzat.

There is only needed a connection between Amiens and Beauvais for there to be an unbroken line between Dunkirk and Auzat, which might be regarded as the "Vertebral column of the electrical skeleton" of France.

(2) Calais, Boulogne, Abbeville, Rouen, Nonancourt, Tours, l'Isle-Jourdain, Tuilières, Agen, Pau, Laruns.

To complete this artery it would be necessary to run a transmission line all the way from Abbeville to Loudun, but "the coupling up of the heat stations at Abbeville and Rouen with the hydro-electric stations at l'Isle-Jourdain and Tuilières would be of great advantage to the whole of the region laying between artery (1) and the Atlantic Seaboard."

(3) Caen, Rai-Aube, Rennes, Nantes, Niort, Bordeaux, Dax, Bayonne.

This artery, to complete which it would be necessary to run lines between Rai-Aube and Nantes, would enable the heat stations of Rai-Aube, Nantes and Bordeaux, to be put in parallel with the hydro-electric stations of the Basses-Pyrénées by way of Bayonne.

(4) Lille-Comines, Vendin, Beautors, Paris, Melun, Troyes, Auxerre, Dijon, Le Creusot, Roanne, Saint-Etienne, Arles.

This artery, which would necessitate the construction of additional lines between Senlis and Paris, Melun and Troyes, Troyes and Auxerre, and Le Creusot and Roanne, lies nearly half-way between Artery (1) and the frontier artery (5), which will be referred to later. It would, however—to the north of Paris—put the heat stations of the coalfields in parallel with those at Beautors and Paris, while, to the south, the Paris stations would be joined up with those at Troyes, Dijon, Le Creusot, Saint-Etienne and Arles. Arles might also be joined up by a short line to Nimes and thus provide a loop between St. Etienne and Arles by way of Brioude and Le Truel, where there is a large hydro-electric station.

(5) Jeumont, Mohon, Conflans, Vincey, Belfort, Ronchamp, Besançon, Pougny-Chancy, Rioupéroux, Ventavon, La Brillane, Sainte-Tulle and Marseilles.

This great frontier artery would permit of the coupling up of the Central heat stations of the North-east with the wonderful collection of Alpine hydro-electric stations and also with the heat station at Marseilles. The whole of the transmission circuit is already run and all that is necessary is to bring the periodicities into agreement. To this artery might be added two alternative routes: (*a*) Circuit 5 *bis* would connect Mohon with Ronchamp by way of Rheims and Troyes, while 5 *ter* would connect Conflans with Belfort by way of La Houve, Strasburg and Mulhouse, which would enable the hydro-electric station at Kembs to deliver energy into Artery No. 5.

This series of five north and south arteries might, Monsieur Mathivet contends, be advantageously completed by the following ten west-to-east lines:—

(*a*) Line No. 6 connects Calais with Jeumont, passing on the way all the heat central stations of the Coal Fields, from that of the Mines de Marles (Chocques) to that of the Mines d'Anzin (Thiers). This line also traverses the towns of St. Omer, Béthune, Lens, Douai and Valenciennes.

(*b*) Line No. 7, which, if completed, by joining Amiens with Beautors and Rheims with Conflans, could connect up the heat station at Abbeville with those at Beautors and La Houve.

(*c*) Line No. 8—a quite new line—would couple up Paris with Havre by way of Rouen, which would enable energy produced by imported British coal to be delivered to the Gennevilliers Station in the Metropolis.

(*d*) Line No. 9, which would necessitate the construction of three important new sections—Brest-Guerledan, Rennes-Rai-Aube,* and Melun-Troyes—would join Brest with Strasburg by way of Paris, and would convey to the Capital, perhaps, the energy produced, in times to come, by Atlantic tidal power, and also that proceeding from the stations at La Houve, Strasburg and Kembs.

(*e*) Line No. 10—which would require the construction of new sections between Nantes and Tours; Orleans and Auxerre; and Dijon and Ronchamps—would connect the maritime city of Nantes with the hydro-electric stations of Strasburg and Kembs.

(*f*) Line No. 11, would allow the hydro-electric station at Pougny-Chancy and the heat station of Le Creusot to feed into Artery (1) at Chailley. This line would require no new construction.

(*g*) Line No. 12, which would provide direct connection between the Alpine hydro-electric station at Viclaire and the Port of La Rochelle, passing on the way the central stations at l'Isle-Jourdain, Eguzon, Roanne and Lyons. This line, which would need junction lines between l'Isle-Jourdain and Eguzon, and between Eguzon and Montluçon, might also feed Artery (1) at Eguzon.

(*h*) Line No. 13 would double Line No. 12 and would allow of the coupling up of the central stations of l'Isle-Jourdain, Coindre, Brioude, Saint-Etienne, Lyons and Viclaire. It, too, might feed Artery No. 1 at Coindre. It would require a new line between Limoges and Coindre.

(*i*) Line No. 14 would connect the heat station at Bordeaux, with the hydro-electric stations at Tuilières and la Mativie-Brommat. The two last-named stations would have to be linked up by a new line.

(*j*) Line 15 would connect up the hydro-electric stations of the Pyrenees and the Alpes, and Bayonne with Nice by way of Dax, Pau, Saint-Gaudens Toulouse, Albi, Le Truel, Nimes, Arles, Saint Tulle and Bancairon. To complete this last circuit it would only be necessary to run the short length of line between Nimes and Arles, which has already been referred to.

Monsieur Mathivet points out that once the connecting links which he suggests were constructed—and he maintains that saving in the north-west they are not very formidable—France would be divided up into fifty regions, each surrounded by a triangular or quadrangular network of extra-high-tension transmission lines. It would only be necessary then, he adds, to run secondary lower tension circuits, in order to supply the whole of all the areas with all the energy they might require.

In conclusion, he remarks: "Thanks to her natural resources: her coal in the north, her streams and rivers in the east and west, her *Massif Central*, her Pyrennean and Alpine frontiers, her seas and her boundless oceans, France will be endowed in a few years' time with an electric equipment of the first rank which will allow her to look forward with confidence to the realisation of the progressive well-being of her inhabitants, and to meet successfully the legitimate calls of unceasing progress." Nowhere, however, does Monsieur Mathivet touch upon the question of cost.

MAP OF FRANCE SHOWING ELECTRIC TRANSMISSION LINES

* Also included in Artery (3).

Cutting Tests with Cemented Tungsten-Carbide Lathe Tools.*

By T. G. DIGGES.

CEMENTED tungsten-carbide tools were first placed on the market on a commercial basis in Europe in 1926 and in the United States several years later. The rapid development of this material during the past year has made possible its extensive use for tools throughout this country and abroad. The records of production with these tools have already shown that this new cutting material will occupy a most important place in our industrial life.

The experiments described in this report relate primarily to a study of lathe tool performance as affected by the conditions of cutting, such as variations in speeds, feeds, and depths, while the composition, the size, and the form of the tools and cutting materials were not varied. The investigation was for the purpose of developing a method of testing tungsten-carbide tools under heavy duty and to establish some of the laws of cutting which define the approximate relations between tests of short duration, which might be made in the laboratory, and long-time cutting required in practical service.

METHODS OF TESTS—EQUIPMENT.

A 36in. heavy duty engine lathe, driven by a 40 H.P., 220-volt direct-current shunt motor, was selected. A link belt chain was used to ensure a positive drive. Accurate speed control of the work piece was secured by using the several gearing ratios of the lathe and by changing the speed of the motor with a variable resistance in the field circuit. Experiments showed that it was necessary to increase the rate of speed of the motor in order to prevent excessive slowing down or stalling under heavy loads.

A special tool holder was designed to give ample support

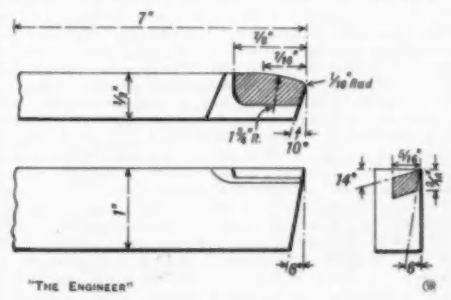


FIG. 1

to the test tool near the cutting edge. This was firmly clamped in a four-bolt tool-post holder.

A "live centre"—tailstock—containing a ball bearing was used instead of the customary "dead centre." Its insertion required considerable time and labour, but it avoided lubrication troubles common with the "dead centre."

A single-pointed cutting tool was selected, and its form—Fig. 1—was similar to that commonly employed for heavy duty roughing work. It consisted of a tungsten-carbide tip, copper brazed on a shank. All tools were hollow ground to a depth of 0·003in. to 0·006in. at approximately 0·25in. from the cutting edge of the tools. Special grinding wheels of silicon carbide were used for grinding the tools.

The tools used in this investigation were manufactured by the Carboloy Company, Inc., by certain sintering operations in which the fine particles of tungsten carbide were cemented firmly together with cobalt, and the material is referred to as cemented tungsten carbide to differentiate it from the cast product. Chemical analyses were made on two lots of tungsten-carbide tools that were supplied at different times. Table I. shows that the tools were quite uniform.

TABLE I.—*Chemical Analysis.*

Lot No.	Chemical composition, per cent.			
	C	W	Co	Fe
1 ..	5·3 ..	81·4 ..	12·7 ..	0·76
2 ..	5·3 ..	81·2 ..	12·6 ..	0·66

PROCEDURE.

From five to eight tools were tested for most of the conditions investigated, and all tests were made in sequence.

* The American Society of Mechanical Engineers—abridged.

For example, in the study of the effect of feed on tool performance, one tool was tested at each of the selected feeds in the series, a second tool was tested at each of the same feeds, and this procedure was continued until the desired number of tools had been tested for each condition. From one to three tests were made with each tool, but no tool after being re-ground was used under the same conditions of test as those under which it had formerly been tested. Only average values are used for comparisons in this report.

Testing tools in sequence has long been practised and tends to minimise variations in results arising from inhomogeneities in the metal being cut. The pieces upon which the cuts were taken, referred to as forgings, were originally from 10in. to 12in. in diameter and from 8ft. to 10ft. in length. In some cases the forgings were cut to diameters as small as 4·5in. in the cutting tests. Average mechanical properties were determined on longitudinal specimens cut from the forgings so as to represent the average metal removed during cutting. The chemical composition, heat treatment, tensile properties, and Brinell hardness of the forgings are given in Table II.

The results of tests at different speeds with a feed of 0·031in. per revolution and depth of 0·1875in. are summarised in Table III. and Fig. 2. Fig. 2 shows that there was a continuous increase in the life of tungsten-carbide tools as the cutting speed was decreased. Within the life range of 9 to 156 minutes the experimental results may be represented by the empirical equation

$$V T^n = c \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

in which

V = the cutting speed in feet per minute,
T = the tool life in minutes,
c = a constant which is dependent upon the cutting conditions other than speed; it should vary with the form and size of tools, material cut, nature of tools, feed, and depth of cut,
n = constant.

Taylor found that the effect of cutting speed on the tool life of high-speed steels could be represented by equation (1). This empirical relationship between tool life and cutting speed with high-speed steel tools was recently confirmed by the Lathe Tool Research Committee and by by equation (1) with $n = 1/8$. Therefore, the equation

$$V T^{1/8} = c \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

was used for all computations in this report involving the relation between the cutting speed and tool life. There was a close concordance between the experimental results and the calculated values, and equation (2) should be sufficiently accurate for all practical purposes, except for extrapolating for very long tool life from tests of short duration. It is of interest to note that this law, as originally developed by Taylor and his co-workers, was confirmed with the cemented tungsten-carbide lathe tools for duration of cut between 9 and 156 minutes under conditions widely different from those of Taylor's experiments.

TABLE II.—*Chemical Composition, Heat Treatment, and Mechanical Properties of the Forgings.*

Forging No.	Chemical composition, per cent.							Heat treatment.*	Proportional limit, lb. per sq. in.	Yield point, lb. per sq. in.	Tensile strength, lb. per sq. in.	Elongation in 2in., per cent.	Reduction of area, per cent.	Brinell hardness number.
	C.	Mn.	P.	S.	Si.	Ni.	Cu.*							
44	0·33	0·72	0·044	0·030	0·28	3·29	0·28	1480 deg. Fah. held 1½ hr.; furnace cooled. 1530 deg. Fah. held 3½ hr., and cooled in emulsion.† 1200 deg. Fah. held 3½ hr.; furnace cooled	81,500	86,500	106,500	26·0	61·3	230
45	0·29	0·65	0·032	0·029	0·32	3·40	0·26	1540 deg. Fah. held 3½ hr.; cooled in emulsion. 1220 deg. Fah. held 2½ hr.; furnace cooled	68,500	76,000	100,000	25·5	60·2	202
52	0·30	0·67	0·038	0·028	0·29	3·39	0·24	1520 deg. Fah. held 3½ hr.; furnace cooled	59,000	60,000	88,800	29·0	53·1	168
53	0·30	0·61	0·026	0·037	0·26	3·43	0·24	1520 deg. Fah. held 3½ hr.; furnace cooled	50,000	51,000	84,200	29·5	47·5	163
54	0·31	0·68	0·042	0·035	0·31	3·17	0·20	1500 deg. Fah. held 3½ hr.; furnace cooled	51,500	54,000	85,200	31·0	55·0	163
55	0·30	0·67	0·034	0·033	0·29	3·37	0·22	1650 deg. Fah. held 3½ hr.; air cooled. 1480 deg. Fah. held 3½ hr.; furnace cooled	58,000	60,250	95,250	30·5	51·8	180
56‡	0·26	0·57	0·041	0·035	0·15	3·81	0·11	1650 deg. Fah. cooled in emulsion; 1560 deg. Fah. cooled in water; 1340 deg. Fah. air cooled	41,100	49,200	85,600	27·5	55·1	166

* Chemical composition and heat treatment data reported by manufacturer.

† The emulsion referred to consisted of 5 per cent. rape seed oil, 15 per cent. paraffin oil, and 80 per cent. water containing 1 per cent. sodium carbonate.

‡ Forging No. 56 was hollow bored; hole approximately 5½in. in diameter. Nos. 44 and 45 were hollow bored; hole 4in. in diameter.

In making a cutting test the tool was clamped so that its side was at right angles to the longitudinal axis of the forging, with the end of the nose on the dead centre. The lathe was then set at the desired feed, the tool at the required depth, and the speed of the lathe adjusted to give the forging the desired peripheral speed. The tool was fed by hand until the desired cut was reached, after which the automatic feed was thrown in and the time recorded. The speed of the forging decreased when cutting began, but was quickly adjusted to bring it back to its original value. Before starting any test care was taken to remove any glazed surface on the forging caused by the breakdown of the previous tool or any particles of the tool that might have become embedded in the forging.

All tests were run dry, and the cutting speed, feed, and depth of cut were varied, depending upon the purpose of each series of tests.

TOOL FAILURE.

A groove was formed on the top surface of the tool near the "leading edge" soon after the tool started to cut. This depression became greater as the test progressed until a condition was finally reached when the wear was sufficient to cause a small section to chip or break out of the working portion of the tool. This "end point" usually resulted in a glazed surface on the test forging and was often accompanied by a splitting of the chip, which gave an additional indication of tool failure. Thus there was a very definite end point and one that could be recognised without much difficulty. In some of the experiments, especially those of the most severe conditions of cutting, this end point was often quickly followed by, if not simultaneous with, tool breakage which would leave doubt as to the time of tool failure. Such doubtful tests were discarded in these experiments. In some cases it would have been possible to continue to cut after the described condition was reached, but only at the expense of badly broken tools. All cutting tests conducted at the Bureau of Standards—French and Digges—and by Ripper and Burley.

Taylor reported cutting tests on carbon steels having a tensile strength of about 70,000 lb. per square inch with tools of definite size and shape made from steel containing about 1·9 per cent. carbon, 8·5 per cent. tungsten, and 2 per cent. chromium. He found the value $n = 1/8$ and $c = 90$, but stated: "We have made a number of experiments . . . with different qualities of steel and find that approximately the same relation exists between the duration of cut and cutting speed for steels of different degrees of hardness. This statement, however, does not apply to cast iron."

Not all investigations have confirmed Taylor's value of the exponent n. Ripper and Burley reported the value of $n = 1/12$, and French and Digges, in cutting tests with modern high-speed tools cutting 3½ per cent. nickel steel of about 100,000 lb. per square inch tensile strength, reported $n = 1/7$ for roughing conditions (heavy duty) and $n = 1/10$ for finishing cuts (light duty).

TABLE III.—*Effect of Speed.*

Forging No.	Cutting conditions.			No. of tests.	Average tool life, min.	Calculated* cutting speed, ft. per min.	Average power required in cutting, kW.
	Speed, ft. per min.	Feed, in. per rev.	Depth, in.				
44 & 45	90	0·031	0·1875	5	155·9	93	4·1
44 & 45	110	0·031	0·1875	6	74·9	108	5·4
44 & 45	120	0·031	0·1875	6	45·9	119	5·5
44 & 45	130	0·031	0·1875	3	26·7	132	6·2
44 & 45	140	0·031	0·1875	6	21·2	139	6·4
44 & 45	160	0·031	0·1875	5	9·0	164	6·8

* Computed by means of equation $V T^n = c$ with $n = 1/5$ and $c = 255$.

EFFECT OF FEED AND DEPTH OF CUT ON THE CUTTING SPEED.

It is not practicable to select a single cutting speed for lathe tool testing varying widely in either feed or depth of cut because of the expense of the large amount of material that would be involved and the time required to make the tests. The cutting speed has already been shown to have an empirical relation to the tool life at a given feed and depth, so that in the study of the effects of feed and depth on tool performance the cutting speed was also varied. In general, cutting speeds giving an average tool life from 10 to 30 min. were selected, and then the cutting speeds for the desired tool life were computed by means of equation (2).

Two series of tests were made with the cemented tungsten-carbide tools in order to establish the relations between the cutting speed, feed, and depth of cut. One was made with a constant depth of cut of 0·1875in. and feeds ranging from 0·031in. to 0·096in. per revolution, and the other with a constant feed of 0·031in. per revolution and depths of cut ranging from 0·125in. to 0·5625in.

The results of the tests made with a constant depth of cut and variable feeds are given in Table IV., and the cutting speeds for a 90-min. tool life with the different feeds used in the experiments are summarised in Fig. 3. As shown in Fig. 3, the relation between the cutting speed and the feed for a given tool life at a constant depth of cut

TABLE IV.—*Effect of Feed.*

Forging No.	Cutting conditions.			Tool life, min.								Average power required in cutting, kW.	Cutting* speed for 90-min. tool life, ft. per min.
	Speed, ft. per min.	Feed, in. per rev.	Depth, in.	Test 1	Test 2	Test 3	Test 4	Test 5	Test 6	Test 7	Average.		
52	160	0·031	0·1875	30·6	11·5	21·2	20·8	20·8	27·3	25·0	22·5	5·5	121
52	120	0·054	0·1875	26·9	31·0	27·3	40·5	12·2	26·4	†	27·4	7·1	94
52	105	0·078	0·1875	23·3	8·0	12·1	16·0	†	12·7	12·6	14·1	8·5	72
52	90	0·096	0·1875	16·7	14·8	19·3	†	9·1	16·7	†	15·3	9·3	63

* Computed from average tool life by means of equation $V T^{1/8} = c$. † Tool broke.

TABLE V.—*Effect of Depth of Cut.*

Forging No.	Cutting conditions.			No. of tests.	Average tool life, min.	Average power required in cutting, kW.	Cutting speed* for 90-min. tool life, ft. per min.
	Speed, ft. per min.	Feed, in. per rev.	Depth, in.				
53, 54, 55	200	0·031	1/8	8	17·7	5·7	144
53, 54, 55	180	0·031	3/16	8	15·1	7·2	126
53, 54, 55	160	0·031	5/16	8	14·4	11·8	111
53, 54, 55	150	0·031	7/16	7	18·5	16·6	109
53, 54, 55	140	0·031	9/16	7	16·5	20·6	100

* Computed from the average tool life by means of equation $V T^{1/8} = c$.

results given in this report were obtained by the "end-point" method described,

The appearance of the forging at the time of failure of the tungsten-carbide tools was very similar to the appearance of a forging when a high-speed steel tool fails under the so-called "lathe breakdown test." A glazed surface was produced on the forging at the bottom of the cut at the time of tool failure.

EFFECTS OF CUTTING SPEED ON TOOL LIFE.

It is a well-known fact that the cutting speed of a high-speed steel lathe tool is dependent upon the quality, composition, and heat treatment of the tool and on the properties of the metal cut, as well as upon the size and form of tool, feed, and depth of cut. It appeared reasonable to assume that the cutting speed of cemented tungsten-carbide lathe tools should depend upon approximately the same variables as high-speed steel tools, and it was upon this basis that the experiments were performed.

Schlesinger, in cutting experiments carried out at the Technological Institute at Berlin with high-speed steel and super-hard metal tools in cutting a steel of approximately 100,000 lb. per square inch (Brinell number of about 190), found that the cutting speed tool life curves for the super-hard metals had the same characteristics as those of high-speed steel. His data show that the relations between tool life and cutting speed for sintered tungsten-carbide tools, where the cross section of the chip was 0·158in. by 0·039in., could be closely represented by equation (1) when $n = 1/4.6$. In another set of experiments which appear to have been carried out under the same test conditions, it was found that $n = 1/7.1$. With high-speed steel tools n was found to be equal to about $1/6.2$, which is in close agreement to the value reported by the Bureau of Standards for roughing tests.

Examination of the results summarised in Fig. 2 shows that the experimental values obtained by sintered tungsten-carbide tools were approximately represented may be represented approximately by the relation

$$V F^m = c_1 \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

in which

V = cutting speed in feet per minute for a selected tool life,
F = feed in inches per revolution,
c_1 = constant,
m = constant.

When operating with cutting speeds for a selected 90-min. tool life at a 0·1875in. depth of cut in cutting a 3·5 per cent. nickel steel forging having a tensile strength in the neighbourhood of 85,000 lb. per square inch, the exponent m was found to be 0·58, with c_1 equal to 16·6. Substituting these results in equation (3) gives

$$V F^{0.58} = 16·6 \quad . \quad . \quad . \quad . \quad . \quad (4)$$

The detailed results as recorded in Table IV. show a surprisingly close agreement between the individual tool

performances. In a majority of the tests this variation was no greater than that ordinarily found when testing high-speed steel lathe tools under heavy duty.

The results of the cutting tests made with a constant feed and variable depths are given in Table V. The cutting speeds for a 90-min. tool life with the different depths used in the experiments are summarised in Fig. 4. The results show that there was a continuous increase in the cutting speed with a decrease in depth of cut and that the relation between the cutting speed and depth of cut with a constant feed and given tool life may be represented by the equation

$$V D^p = c_2 \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

in which

V = cutting speed in feet per minute for a selected tool life,
D = depth of cut in inches,
c_2 = constant,
p = constant.

It was found that p was equal to 0·2 and that c_2 was equal to 90, for a 90-min. tool life, and with a feed of 0·031in. per revolution and depths of cut varying from 0·125in. to 0·5625in. Substituting these results in equation (5) gives

$$V D^{0.2} = 90 \quad . \quad . \quad . \quad . \quad . \quad . \quad (6)$$

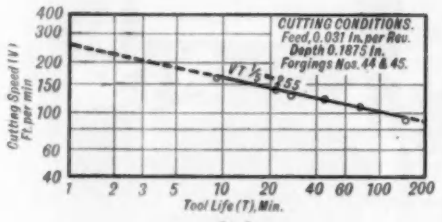
An examination of Fig. 4 shows that there was a close agreement between the experimental and calculated values over a wide range of depths of cut.

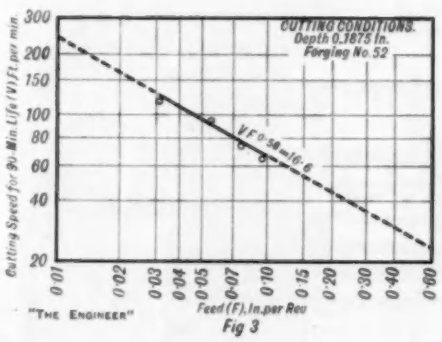
From equations (4) and (6) for a 90-min. tool life there is obtained

$$V F^{0.58} D^{0.2} = K = 12 \quad . \quad . \quad . \quad . \quad . \quad (7)$$

The equations given in this report check with the experimental values closely and can be used as the basis for computing speeds for a selected tool life under varying conditions, provided the size, form, quality, and composition of tools and the type of cutting material herein described are used.

As shown by equation (7), the cutting speed is not affected equally by changes in feed and depth of cut. A higher cutting speed is more closely associated with a deep cut and fine feed than with a corresponding combination of coarse feed and shallow cut. Equations (2) and (6) show that the exponents n and p, expressing the relation between cutting speed and tool life and the cutting speed and depth of cut are equal.


CUTTING CONDITIONS.
Feed, 0.031 In. per Rev.
Depth 0.1875 In.
Forgings Nos. 44 & 45.
VT 1/2 = 855
Cutting Speed (V) Ft. per min.
Tool Life (T), Min.
Fig 2


CUTTING CONDITIONS.
Depth 0.1875 In.
Forging No. 52
VF 0·58 = 16·6
Cutting Speed for 90-Min. Life (V) Ft. per min.
Feed (F), In. per Rev.
"THE ENGINEER"
Fig 3

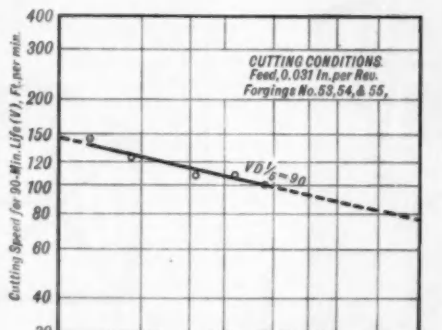
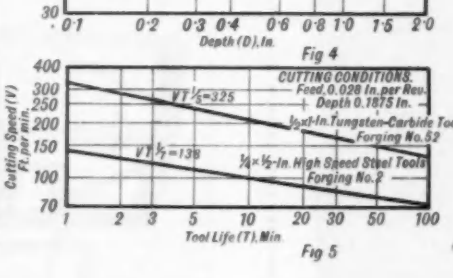


Fig 4


CUTTING CONDITIONS.
Feed, 0.028 In. per Rev.
Depth 0.1875 In.
VT 1/5 = 325
½ x 1-In. Tungsten-Carbide Tools
Forging No. 52
VT 1/7 = 139
¼ x ½-In. High Speed Steel Tools
Forging No. 2
Cutting Speed (V) Ft. per min.
Tool Life (T), Min.
Fig 5

General Comments on the Lathe Tests.

Despite the fact that cemented tungsten carbide contains appreciable proportions of cobalt, it is a relatively brittle material, and for this reason the cutting tools must be well supported. For these tests the carbide tips were joined to the tool shank by copper brazing in a hydrogen atmosphere. Hoyt states: "It has been found that tungsten-carbide tips which are rigidly welded to the shank are only too apt to come off, either directly after the tool is made or after being put in service. This is due to thermal stresses which are set up by temperature changes and differences in the coefficients of expansion of the carbide and the steel. This circumstance accounts for the popularity of copper brazing, because here the thin layer of copper affords a soft cushion which absorbs such stresses without transmitting them to the carbide tip. On the other hand, copper softens at elevated temperatures, so that it is necessary, in the design of the tool, to remove the joint far enough away from the cutting edge so that it does not get dangerously hot during operation."

This method of attaching the carbide tip was satisfactory for most of the conditions used in the cutting tests, although premature failure in several tests resulted because of the rupture of this bond.

The heaviest cuts used with the 0·5in. by 1in. tools were probably greater than those that could be used in ordinary shop practice where cost due to tool breakage becomes important. The carbide tips of the tools were reduced in size by grinding and weakened accordingly, so that most of the tool breakage was confined to the heaviest cuts with tools that had been reground. The tests showed that the tools could be used under relatively heavy duty provided they were properly supported and not subjected to vibration.

The forces on a lathe, too, while cutting, are practically independent of the cutting speed and are dependent upon the cross section of the chip. It is evident from this principle that tungsten-carbide tools should be used at relatively high speeds and for light cuts in order to keep tool breakage at a minimum. As shown by equation (2), the cutting speed varies as the $^1/_5$ power of the tool life. This indicates that a small change in cutting speed causes a correspondingly large change in the tool life, so that the higher cutting speeds are obtained only at the expense of shorter tool life. The most economical cutting conditions must, therefore, be a compromise between several factors, such as increase in cutting speed with decrease in tool life and tool breakage, in order to remove the maximum amount of metal in the minimum time at the least cost.

Some idea of the relation between the cutting speeds associated with tungsten-carbide tools and high-speed steel tools may be obtained from the cutting speed tool life curves reproduced in Fig. 5. Attention is directed to the fact that the two curves were not made under identical conditions of cutting, and only a general comparison can be made from these results. For example, the tungsten-carbide tools are larger than those used in the high-speed steel experiments, and the tool angles are different for the two types of tools.

The high-speed steel tools were of the 18 per cent. tungsten type, quenched in oil from 2400 deg. Fah., and tempered at 1100 deg. Fah. These tools were 0·25in. by 0·5in. in size and were ground to a front and side clearance of 6 deg., side slope of 8 deg., back slope of 14 deg., and a nose radius of 0·125in. The cutting materials, as shown in Table II., had approximately the same chemical and physical properties, but, as already pointed out, it does not necessarily follow that the two forgings have the same cutting properties. Both forgings were of the 3·5 per cent. nickel type, heat treated to give a tensile strength of about 85,000 lb. per square inch.

Fig. 5 shows that considerably higher cutting speeds —under certain conditions—were obtained with the tungsten-carbide tools than with the high-speed steel tools. Also, the slopes of the straight lines representing the relation between cutting speed and tool life with the logarithmic system of co-ordinates were different for the two types of tools. The slope of the curves obtained with the tungsten-carbide tools was greater than that obtained with the high-speed steel tools. This means that the two curves tend to approach each other, and the differences between the cutting speeds of the two materials decrease with increase in tool life. If these curves are extrapolated to an extremely long tool life, then the curves will cross, and the high-speed steel tools would show higher cutting speeds than the tungsten-carbide tools. However, such long-time cutting cannot be extrapolated with any degree of accuracy from the present empirical equations, and it is also doubtful if cutting conditions resulting in such long tool life would ever be practicable in modern shops from an economical standpoint.

While the tungsten-carbide tools were considerably superior to those of high-speed steel in cutting 3·5 per cent. nickel steel forgings of about 85,000 lb. per square inch tensile strength, it does not follow that the same degree of superiority will be obtained under widely different cutting conditions, especially where heavy feeds and deep cuts are used. Therefore, it is necessary to know exactly the cutting conditions in order to make a comparison of the two types of tools.

No direct indication of the performance of the tungsten-carbide tools could be detected by the types of chips produced in the lathe tests. In general, the chip came off in very long ribbons during the first part of the cut, and then became shorter with more curl as the cutting time increased, until a short time before tool failure the chips were approximately 0·5in. to 1in. in length. While these chips were characteristic for some of the conditions employed, especially with tools tested on forging No. 52, they were not characteristic of the tools tested under conditions of varying depths of cut on forgings Nos. 54 and 55. In the latter case the long chips often continued until tool failure.

The power required in cutting was determined in all of the lathe tests with tungsten-carbide tools and was determined at frequent intervals throughout the life of the lathe tools, so that only average values were obtained. The instruments used, however, did not permit determinations of the fluctuations or the maximum momentary power consumption. The results given in Table III. show that, at constant feed and depth of cut, the power was approximately proportional to the cutting speed. The exact relations between the feed and depth of cut and the power consumed cannot be established at this time. The results given in Tables IV. and V. show that there was an increase in the power with increase in feed or depth. However, as already pointed out, the feed and depth experiments were not made at a constant speed, so that the magnitude of the changes in power due to changes in feed or depth cannot be established from the limited number of tests made. The power determinations are included with the test results in order to show that it is necessary to have machines equipped with powerful driving units in order to utilise the full capacity of tungsten-carbide tools.

OBITUARY.

JOSEPH WILLIAM WILSON.

It is with regret that we have to place on record the death on Wednesday, September 3rd, of Mr. Joseph William Wilson, who, with his father, the late Joseph William Wilson, was the co-founder in 1872 of the Crystal Palace School of Engineering. He was the first vice-principal of the school, and in 1878 he succeeded his father as its principal. At the time of his death he was president of the school, the present principal being Mr. Maurice Wilson, his brother. Mr. Wilson was born in Birmingham on November 22nd, 1851, and he received his early education at Dr. Pinches' School at Kennington. He served his time in engineering shops and then entered his father's office as a civil engineer in Westminster. The office had its own fitting and pattern shop, and the training thus combined theoretical and practical work. It was their strong belief in this combined training which led the Wilsons to suggest to the Crystal Palace Company the founding of a School of Engineering. The school premises were actually in the Palace until quite recently, when they were moved to Anerley-hill. Mr. Wilson became an associate member of the Institution of Civil Engineers in 1877 and a member in 1900. He was elected a member of the Institution of Mechanical Engineers in 1890 and was President of the Society of Engineers in 1892 and again in 1908. He was also an honorary member of the Junior Institution of Engineers. He served on Lord Brassey's organising committee for the International Maritime Congress of 1893 and was a vice-president of the Incorporated Society of Inspectors of Weights and Measures.

American Engineering News.

High-pressure Locomotives.

Successful experience with a first engine carrying 350 lb. pressure and a second carrying 400 lb. has led the Delaware and Hudson Railroad to construct a third engine carrying 500 lb. Each has a water-tube fire-box, a fire tube boiler, and horizontal steam drums. The new engine, named "James Archbald," after one of the early engineers of the railway, is of the 2–8–0 type, with a two-wheeled leading bogie and eight coupled drivers; its immense tender, mounted on four-wheeled bogies, has a booster engine on the rear bogie, the wheels of which are connected by coupling-rods. The engine is a two-cylinder compound. For the water-tube fire-box the sides are composed of nests of curved tubes connected to drums below the grates and steam drums above the boiler shell, these latter drums being twice the length of the fire-box. The main dimensions and particulars are as follows:—

High-pressure cylinder	20½in. by 32in.
Low-pressure cylinder	35½in. by 32in.
Driving wheels	5ft. 3in.
Wheel base—	
Driving	18ft.
Engine	29ft.
Engine and tender	80ft.
Weight on drivers	145 tons
Weight of engine	173 tons
Weight of engine and tender	310 tons
Boiler, diameter	5ft. 8in.
Boiler, length of tubes	15ft.
Fire-box	12ft. 8in. by 6ft. 6in.
Steam drums—	
Diameter	2ft. 5in.
Length	29ft.
Water drums	12ft. 8in. by 1ft. 8in.
Heating surface—	
Fire-box and arch tubes	1,114 square feet
Boiler	2,325 square feet
Total	3,439 square feet
Superheating surface	1,037 square feet
Tractive force—	
Simple	84,300 lb.
Compound	70,300 lb.
Booster engine	18,000 lb.
Water in tender	14,000 gallons
Coal in tender	40,000 lb.
Grate area	82 square feet

Drainage Water for Irrigation.

Lands adjacent to and at a lower level than those of irrigation districts are often subject to injury by the excess irrigation water, which raises the level of the ground water, so that the land becomes water-logged or sour, while sometimes it causes alkali salts to come to the surface and make the soil barren. In many cases it has been necessary to drain this lower land by means of open ditches or tile underdrains, but these methods are not always successful, as the continual flow of excess water causes slogging or is of too great volume unless drainage of prohibitive cost is provided. A remedy which has been tried with success in some cases is to sink wells and install pumps to remove the water and deliver it to neighbouring lands which need irrigation. These wells are 12in. to 18in. in diameter, lined with light sheet steel pipe, which is driven to a little below the normal ground-water level, and is perforated where it passes through the water-bearing stratum in which the escaped or excess water is flowing. For satisfactory results it is necessary to study each individual case. In one district the wells were 100ft. to 150ft. deep, each equipped with a motor-driven pump. The wells are of the gravel packed type, having clean gravel packed outside the strainer or perforated section in order to prevent so rapid a flow as to cause fine sand to pack around it and practically shut off the well. The pumping lowers the water level more effectually and to a greater depth than is practicable with ditches. Besides this, water from ditches or drains runs to waste, while the pumped water is available for use, which is an important point where water is scarce.

(For description see opposite page.)

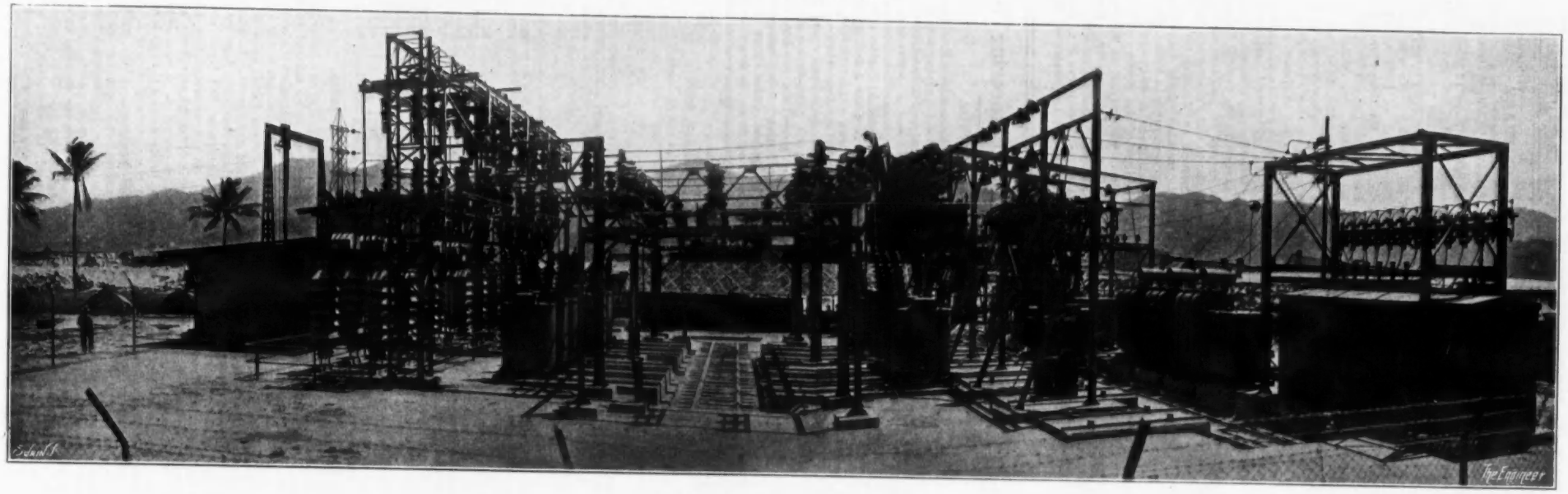


FIG. 16—THE SELIBIN SUB-STATION

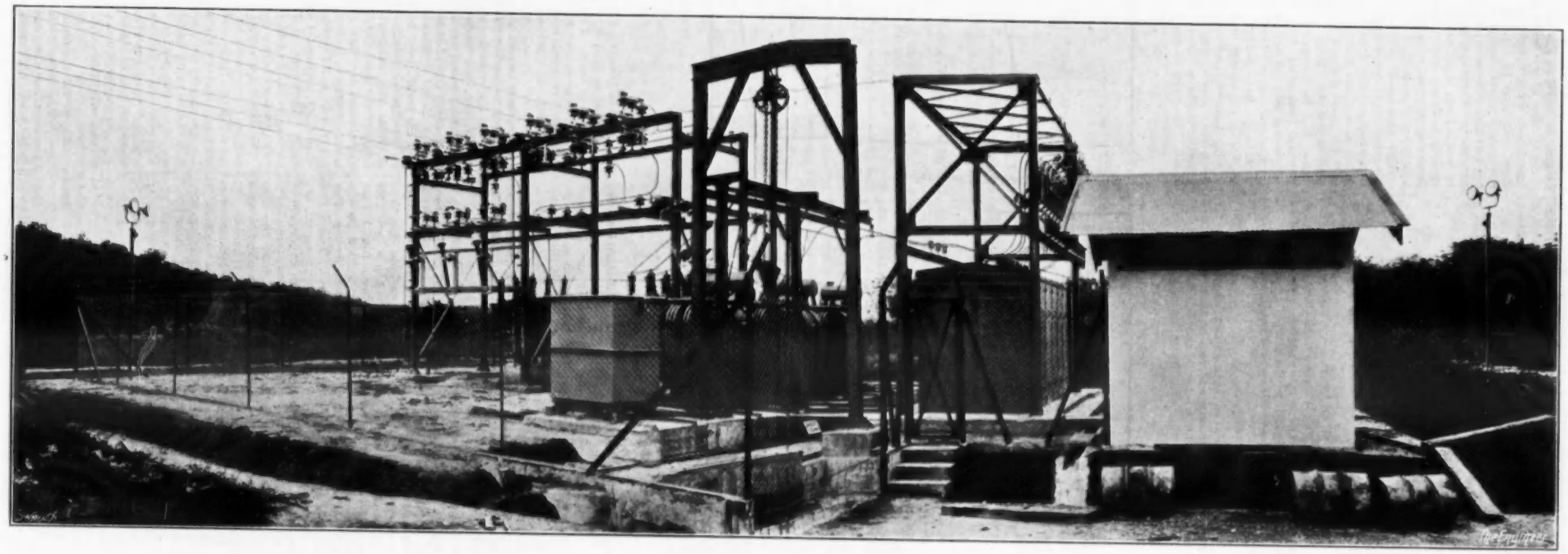


FIG. 17—THE TRONOH SUB-STATION

The Perak River Hydro-electric Power Scheme.

No. III. (*Conclusion*).

DISTRIBUTION SYSTEM.

THE map, Fig. 1, shows the main distribution lines of the system. From it it will be seen that the two power stations are joined by the primary 66-kV double line, which is 53 miles long. There are three intermediate tapping points on this line, at Sungei Siput,

FIG. 1—THE PERAK AND KINTA RIVERS
(*Reproduced*)

Selibin and Talang Pamaya, where step-down sub-stations are provided for supplying secondary lines at 22 kV and local feeders at 6·6 kV. The secondary lines consist of double 22-kV lines from Malim Nawar to Kampar and Temoh, and from Talang Pamaya to Tanjong Toh Alang, which are now being extended to Petaling, and a single loop line joining Selibin to Talang Pamaya and supplying Menglembu, Papan, Batu Gajah and Tronoh. The total length of the double 22-kV lines, including the Petaling extension, is 19½ miles, and the loop line is 17½ miles long.

The local distribution from the above-mentioned sub-stations is made at 6·6 kV. The feeders vary in length, depending on the situation of the consumers' mines. The longest is about 3½ miles. Where possible, several consumers are supplied from one feeder.

The primary and secondary lines are carried on galvanised steel lattice towers with three cross arms, so that one circuit may be arranged on each side of the towers. The single-line loop is also carried on a double-circuit tower in order to reduce the number of different types used. The towers for the primary line are about 68ft. in height and are designed for a minimum clearance between the lowest conductor and the ground of 21ft. The secondary lines have the same ground clearance.

On the 66-kV lines there are three types of tower—(1) the intermediate or suspension type used for normal spans and equipped with a single string of insulators consisting of six discs in series; (2) the angle and strain type, somewhat heavier in construction and used for deviations of the line exceeding 5 deg.; (3) the transposition type, having a longer upper and lower cross arm to enable transposition of phases to be effected. The strain and transposition types are fitted with two strings of insulators, each consisting of seven discs in series. An earth wire is carried on the top of the towers.

For the 22-kV lines three types also are used, namely, intermediate, strain and angle, and transposition towers. The two first-named types are equipped with pin insulators and the transposition towers with two strings of two-disc suspension insulators. An earth wire is carried on the top of each tower. In the case of the line between Malim Nawar and Temoh an exception had to be made in order to give the lines sufficient clearance over the numerous mine dumps in the vicinity, and 66-kV towers with suspension instead of pin type insulators were used on this section. Two discs in series were first fitted, but it was considered advisable to strengthen the insulation by the addition of a third disc, owing to the prevalence of lightning storms in the area.

The towers are normally secured to stubs set firmly in the ground, but in some places piled concrete foundations were necessary. In particular the tower footings in the swampy ground around the Kinta River on the Malim Nawar-Talang Pamaya section were especially difficult on account of the lack of means of transport to the sites. Eventually a bank was constructed through the swamp and a light railway track laid down to convey the piles and tower material to the sites. In Figs. 18 and 19 photographs are reproduced which show graphically the nature of the difficulties encountered in the Kinta swamp. Fig. 20 shows a tower completed erected.

The 6·6-kV lines for local distribution are carried on steel tubular poles with a single cross arm fitted with pin insulators, the earth wire being carried below the conductors. Tee-offs are arranged where necessary on these lines by means of a structure embodying four poles carrying one or more air-break switches.

The flash-over values of the insulators used are as follows :—

	66 kV (6 discs in series).	22-kV pin.	6·6-kV pin.
Dry ..	.. 315 kV ..	.. 160 kV ..	.. 75 kV
Wet ..	.. 195 kV ..	.. 120 kV ..	.. 42 kV

Hard-drawn stranded copper wire is used for the conductors, the primary lines having a section of ·125 square inch from Chenderoh to Talang Pamaya, and ·1 square inch from the latter point to Malim Nawar. The 22-kV lines are all ·1 square inch and the earth wire is ·05 square inch. The 6·6-kV lines have different sections varying with the length and power to be transmitted. The standard sections used are ·1, ·075, ·05, and ·022 square inch.

There are eleven sub-stations on the system, of which three take their supply from the primary 66-kV line and the remainder are supplied at 22 kV. The 66-kV sub-station at Sungei Siput has not been fully equipped under the present development, as the demand for power in that area does not yet justify the expenditure. All sub-stations are of the outdoor type with bus-bars and isolators carried on a steel girder structure to which the transmission lines are strained. Their local supply is at 6·6 kV, the switches controlling these feeders being housed in outdoor sheet steel cubicles. A diagram of connections for the scheme is shown in Fig. 21.

The Talang Pamaya sub-station has no local supply, there being no mines in the neighbourhood, but it serves as a supply point for the 22-kV lines to Tanjong Toh Alang and the ring main to Selibin. It is equipped with a 10,500-kVA bank of transformers and the neutral on the 22-kV side is earthed through a Petersen coil to protect the 22-kV lines radiating from this point. The oil switches on the 66-kV and 22-kV systems are electrically operated, the control panel being situated in a small switch house.

The Selibin sub-station—Fig. 16, page 250—is similar to that at Talang Pamaya, except that a local 6·6-kV supply is required at this point. This supply is obtained by stepping down direct from 66 kV

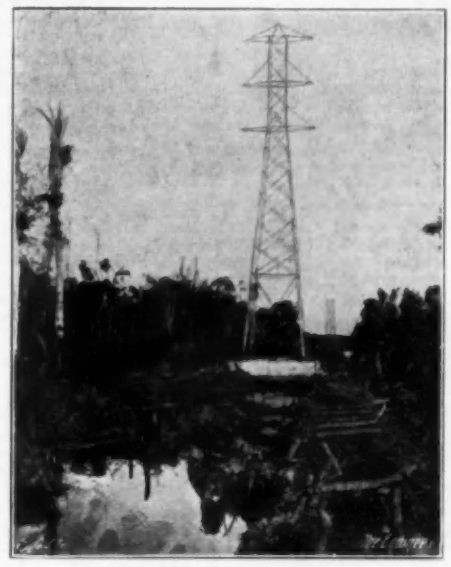


FIG. 20—TRANSMISSION LINE TOWER

independently of the supply to the 22-kV bus-bars. The two transformer banks at this station are rated at 5000 kVA for the 66/22-kV bank and at 3000 kVA for the 66/6·6-kV bank. A supply at 22 kV is given by this station to the adjoining Government sub-station for distribution in the town of Ipoh, replacing the oil engine generating station previously in use at that town.

The remaining sub-stations all receive their supply at 22 kV and are single or double bus-bar stations, as indicated in Fig. 21. They are equipped with one or two banks of transformers, according to the load in the neighbourhood. Two sizes of single-phase transformers, 750 kVA and 500 kVA, are employed to make up the banks in these stations, in order to reduce the number of spare units required. The stations at Tanjong Toh Alang, Petaling and Temoh are provided with 22-kV feeders in addition to the 6·6-kV feeders in order to supply several large mining undertakings in the vicinity at that voltage.

Lightning arresters are provided on all the lines and feeders at each sub-station, those on the 66-kV system being of the oxide film type and the remainder of the pellet type. No choke coils, however, are fitted. The neutral point of the transformers is earthed through a resistance at each of the secondary sub-stations.

The 6·6-kV gear consists of groups of six sheet steel cubicles for controlling the incoming supply from the transformer bank, four outgoing local feeders and the sub-station lighting and potential transformer

FIG. 18—COOLIES MANOEUVRING PILE IN SWAMP

FIG. 19—PREPARING TO SLING A PILE FOR TOWER NO. 32

No. II. appeared August 29th.

supply. At the end of each group a seventh cubicle has been added containing bus-bar isolators to enable further feeder cubicles to be added without interruption of supply. A second group of four feeders has already been installed at Kampar. Fig. 17, page 250, shows the sub-station at Tronoh.

The switches—except the local feeders, which are all hand-operated—at Talang Pamaya, Selibin, Tanjong Toh Alang, and Petaling, are electrically-operated from a storage battery. The control panel and battery-charging set are installed in the small switch house at the sub-station. These battery-charging sets, the output of which is 8 kW, are supplied from a small 30 kVA or 50 kVA transformer at 400 volts. At all other secondary sub-stations the 22 kV switches are hand-operated, as are also the 6·6-kV switches.

The protective system adopted for the generators and transformers is of the Merz-Price circulating-current type. In the Chenderoh station the generators and their respective transformer banks are treated as one unit. In the case of sub-station transformers the relays operate to trip both the high-tension and low-tension switches.

The main 66-kV line is equipped with differential-phase and earth leakage protection at each sub-station. This equipment is so arranged that under fault conditions it operates to trip out the more heavily loaded line, disconnecting it from all the sub-stations. As a standby to this system, overload and earth leakage relays are provided for each line independently of the other, but these relays are given a long time lag in order to afford the differential protection time to operate. These standby relays also afford protection when only one line is in service. The potential supply required for the directional elements is obtained from a special condenser consisting of three condenser type bushings, connected to the line and mounted on a tank with their lower ends immersed in oil. The potential supply is tapped off one of the layers of each bushing, thus eliminating 66-kV potential transformers.

The protection of the double 22-kV lines is similar to that used for the 66-kV lines, except that potential transformers are employed to operate the directional relays. The single loop line has overload relays only at each of the stations on it. All sub-stations are protected against bus-bar earth faults by a relay operated from a current transformer in the sub-station structure earthing connection.

The 6·6 kV feeders are provided with relays connected with two poles for overload and the third for earth leakage. The relay settings are high in order that faults on the consumers' apparatus may be cleared by the protective gear at the supply end.

The sub-station transformers throughout are oil-immersed self-cooled single-phase units, grouped in banks, and star connected on one side and delta connected on the other in such a way that each section of the lines has only one neutral point which is earthed. The transformers are of the core type with concentric windings, the end coils of which are specially insulated to withstand high voltages caused by line surges. The tanks are all provided with oil expansion vessels, and in the pipe connections to these vessels Buchholz relays have been fitted on all 66-kV units and also on both 22-kV banks at Malim Nawar.

The largest self-cooled transformers are those at Talang Pamaya, each single-phase unit having a capacity of 3500 kVA. These transformers operate without any protection from the sun with a temperature rise in the hottest part of the oil not exceeding 35 deg. Cent. on full load. One spare transformer is installed at each station, except in the smaller 22-kV stations, where one spare serves two sub-stations. This spare can be transported on a lorry to the required point.

The consumers' equipment is generally provided by the mining company, space being arranged for the power company's meters on the switchboard. In the case of small consumers, however, the power company has a number of kiosk type sub-stations and motor equipments which are available for hire. The sub-station consists of a kiosk with expanded metal sides and sheet steel roof, and is of sufficient size to accommodate a three-phase step-down transformer, of a maximum size of 300 kVA, together with an oil switch and meter panel. The motor equipments comprise a three-phase induction motor, starting switch and speed-regulating resistance, and a static condenser, which is permanently connected across the stator terminals, giving a full load power factor to the unit of 0·91.

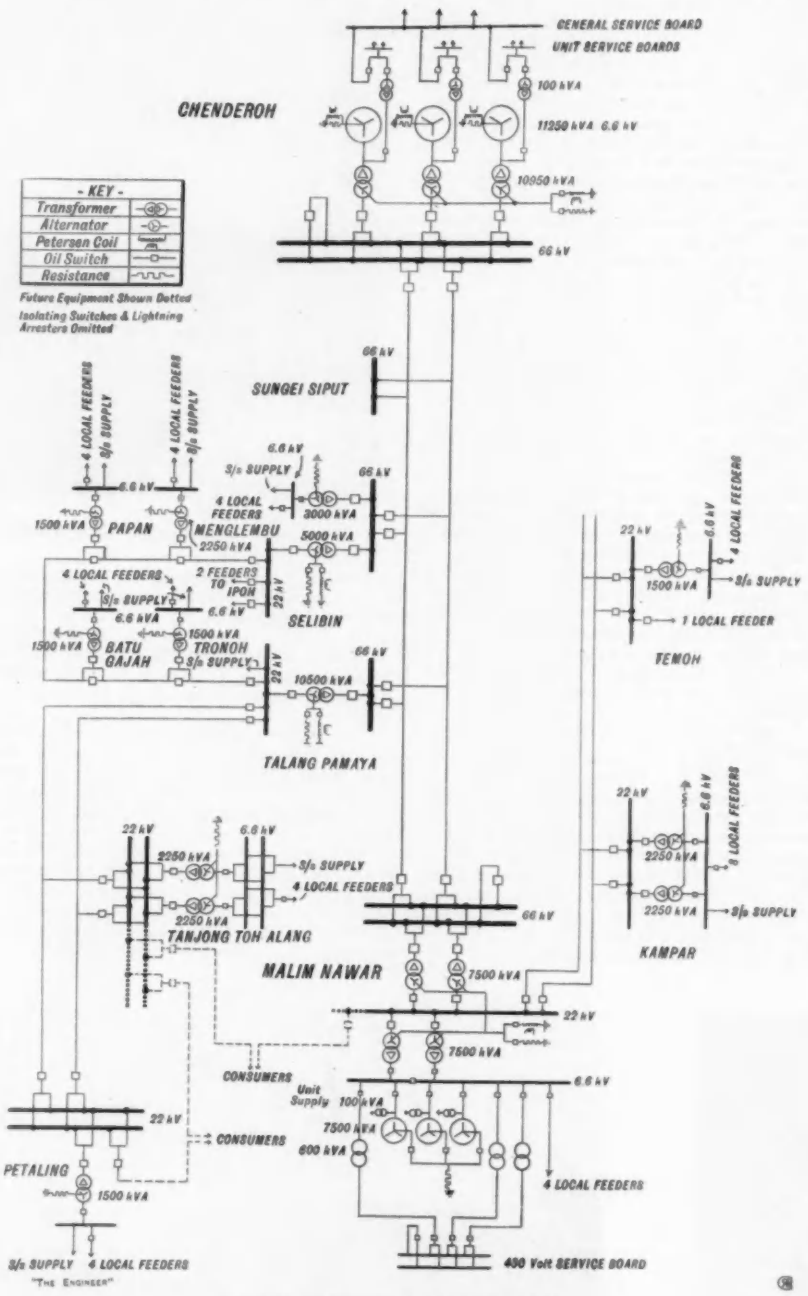


FIG. 21—DIAGRAM OF CONNECTIONS

The power company does not distribute electricity for domestic use, but gives a supply in bulk to the Government station at Ipoh and also to the Kinta Electrical Distribution Company, Ltd., which distributes energy in the smaller towns and villages, in some twelve of which electricity is now available.

During the final eighteen months of construction work at Chenderoh, the steam station at Malim Nawar was operated continuously. In that period the average load on the system grew to some 10,000 kW and the monthly load factor on the station reached 77 per cent. This is a remarkably high load factor, especially when it is remembered that the demand was steadily increasing. The power factor at the station corresponding to the above figure was 82 per cent. It is estimated that when the system is fully loaded the annual load factor will reach 80 per cent.

The hydro-electric station at Chenderoh has now been put into commercial operation and is supplying power to the system. The load is gradually being transferred to it from Malim Nawar, which station will then be shut down for overhaul until it is required for augmenting the output of the hydro-electric station during the next dry season.

The engineers and principal contractors concerned in carrying out the scheme were as follows :—

CONSULTING ENGINEERS.

Messrs. Rendel, Palmer and Tritton, in conjunction with Messrs. Vattenbygnadsbyran. Collaborators for the steam station, Messrs. Sparks and Partners.

CONTRACTORS.

Chenderoh.	
Civil engineering work	Topham, Jones and Railton, Ltd.
Taintor gates	Glenfield and Kennedy, Ltd.
Sector gates and intake gates	Ransomes and Rapier, Ltd.
Water turbines	The English Steel Corporation, Ltd.
Alternators	The English Electric Co., Ltd.
Travelling cranes	Sir William Arrol and Co., Ltd.
Steam Station.	
Boiler plant and buildings	International Combustion, Ltd.
Turbo-alternators	The English Electric Co., Ltd.
Sub-stations and Transmission Lines.	
Sub-station switchgear	Metropolitan-Vickers Electrical Export Co., Ltd.
Transmission lines	British Insulated Cables, Ltd.
Transformers	Asea Electric, Ltd.
Motors for hire	The British Thomson-Houston Co., Ltd.
Petersen coils	The A.E.G. Electric Co., Ltd.
Private telephones	British Insulated Cables, Ltd.

Railway and Road Matters.

THE position of chief stores superintendent to the London, Midland and Scottish Railway, vacant owing to the retirement of Mr. W. A. Rea, is to be filled by an engineer. As from September 1st the new superintendent will be Mr. W. K. Wallace, the locomotive and permanent way engineer of the Northern Counties Committee, Belfast.

IT is officially announced that there is to be a special general meeting of the National Union of Railwaymen on October 24th to consider the proposals of the executive committee that the companies be approached as to a minimum wage of £2 10s. per week for all adult employees, together with the consolidation of the existing war wage of railway shopworkers and a guaranteed week for the latter.

IN this column of our issue of August 22nd, we quoted the Horwich correspondent of the *Manchester Guardian* as saying that twelve new engines were to be built at Horwich works in 1931. The same correspondent now announces that instead of twelve of the heavy mixed traffic engines, there are to be fifteen light tank engines. The writer adds that the alteration is regarded as further evidence of railway economy. The tank engines will cost less to build than the type previously considered, and though fifteen are ordered there will be a considerable saving in wages and material costs.

THE comparatively frequent announcements in the newspapers of branch lines being closed down as regards passenger traffic provokes memories of the expectations that were to follow the original opening of some of them. One such is the Grassington branch of the former Midland Railway. That line was promoted by the Yorkshire Dales Railway Company and ran from Skipton in a north-easterly direction and it was hoped by its promoters that it would form part of a line, through Richmond, to Darlington, which would break the monopoly of the North-Eastern, and obviate the circuitous route from Liverpool and Manchester, through Leeds or through Normanton. Admirers of North Wales and of the Isle of Anglesey will regret to hear that the Carnarvon and Llanberis and the Red Wharf Bay branches are also to be closed.

WE would like to supplement the paragraph headed "A Famous Locomotive," which appeared in the Sevenday Journal on August 29th, by saying that the single driving wheel locomotive therein referred to as being withdrawn from service is not only the last such engine in use in Scotland, but the only one on British railways. On page 71 of THE ENGINEER of July 17th, 1925, we published a table of the number of locomotives, divided with the various wheel arrangements for each company. That was based on information published in the 1924 annual reports of the companies, and at that time there were 52 of the 4-2-2 type, of which the London, Midland and Scottish had 43, the London and North-Eastern had three and the Southern six. By the end of 1927, the L.M.S. had only four, the L. and N.E. had none, and the Southern had one. The last disappeared during 1928, as did three of the four on the L.M.S., leaving only one on the latter line and on the whole of the British system.

ACCORDING to the Board of Trade returns, the value of the railway material exported during the first seven months of the present year were as follows, the corresponding figures for 1929 and 1928 are added in brackets :—Locomotives, £2,158,244 (£1,807,272, £2,219,866); rails, £1,528,577 (£1,627,949, £2,159,035); carriages, £988,532 (£1,286,720, £1,718,156); wagons, £1,905,552 (£1,517,721, £2,051,622); wheels and axles, £206,175 (£254,647, £523,927); tires and axles, £409,463 (£305,147, £346,406); chairs and metal sleepers, £487,928 (£293,250, £614,417); miscellaneous permanent way, £520,681 (£637,793, £857,795); total permanent way, £3,236,688 (£3,207,643, £4,576,256). The weight of the rails exported was 175,090 tons (195,531 tons, 249,728 tons), and of the chairs and metal sleepers, 52,407 tons (29,144 tons, 61,897 tons). During the month of July last the value of the locomotives shipped overseas was £203,662, which included : India, £76,951; other countries than the Argentine in South America, £17,920; Ceylon, £10,750; South Africa, £6359, and the Argentine, £4146. During the same month the rails sent overseas were of the value of £263,822, and included : The Argentine, £124,476; South Africa, £95,684; New Zealand, £14,104; India, £7671; Ceylon, £2764.

THE Railway Staff Census of the Ministry of Transport is an annual Stationery Office publication, price 1s. On the present occasion it refers to the number of men employed during the week ended March 8th last and compares with the corresponding week of 1929. At first sight the figures cause surprise, as, despite the falling off in trade, the number employed had risen from 642,137 to 656,530. On reference, however, to earlier returns, wherein it is found that in 1928 the total was 677,148 and in 1927 it was 683,077, we feel that we may offer the suggestion that in 1929 the economies in the staff had reached a level that was uneconomic and that more men had to be put on. Comparisons thus should be made with 1928 and not with 1929, and they show that the Great Western increased its total staff from 110,591 to 110,729, the London and North-Eastern had a reduction from 200,517 to 195,030, the London, Midland and Scottish one from 262,878 to 250,742, and the Southern a drop from 73,005 to 71,488. As showing the variations in sundry ranks between 1928, 1929, and 1930, we would say that engine cleaners dropped from 10,594 in 1928 to 6851 in 1929, but are now 8992. As it might be thought that that was due to a transfer of this work to other grades it should be said that the figures for locomotive shed staff were 10,580, 10,406, and 10,399 respectively, and there was little variation in the number of firemen. There was a great difference in the labourers, too, as their respective figures were 29,131, 25,560, and 28,101; permanent way men, again, were 64,289, 59,463, and 61,557; and shopmen were 113,670, 104,496, and 110,385. The total amount paid in salaries and wages in 1929 was £117,997,000 and it was £115,284,000 in 1928. In making any comparison between these two it must be remembered that the former figure covered a whole year of the 2½ per cent. reduction and the latter had 4½ months.

Notes and Memoranda.

THE average cost of electricity supplied by the Electricity Supply Commission of South Africa is, according to the latest official reports, 0·298d. per unit.

IN the process of building the 85-storey Empire State building in New York, structural steel is being put in place at the rate of about 10,000 tons a month. The building has a base of 425ft. by 198ft., and will require 57,000 tons of steel. The building is to be surmounted by an airship mooring mast.

THROUGH the courtesy of H.M. Medical Inspector, the *Chemical Trade Journal* is able to give the composition of an antiseptic wash for oil dermatitis, namely : Chlorinated lime—powdered—175 grammes ; sodium bicarbonate —crystals—350 grammes ; boric acid—powdered—35 grammes, and water up to 30 oz. This wash is used in a dilution of 1 in 10 and is followed by a thorough rinsing with soap and water.

THERE is a quaintness in the lines beneath an illustration in the *Engineering News-Record*, which purports to display "silver" bridges across the Allegheny River at Pittsburg. No one would, of course, dream of making a suspension bridge of silver, but is it not debasing an already base metal when the use of aluminium to paint bridges is used as an excuse for describing them as of a more noble metal ? We would prefer to give aluminium itself its due.

A RATHER unusual craft has recently been commissioned in America at New Orleans, and is claimed to be the largest tug built for inland service. She is 200ft. long by 40ft. beam and displaces 1170 tons on a draught of 6½ft. The propelling machinery comprises twin-screw triple-expansion engines of 2100 horse-power working propellers 8ft. 9in. in diameter in tunnels. It is said that this tug will handle a string of barges totalling over 5000 tons.

FOR the purpose of ventilating a cable junction vault in Glasgow, a device supplied by the Glasgow Electrical Engineering Company has been installed on the top of one of the adjacent tramway standards. It virtually comprises a small windmill driving a fan, which sucks air through the vault by means of appropriate ducts. It is said that with a wind blowing at about 10 miles per hour, the ventilation effect is 15·5 cubic feet of air per minute.

FOR its weight, white spruce is one of the strongest of Canadian woods. It is stronger than woods approximately its own weight, such as the white pine, and it possesses nearly the same relative strength, weight for weight, as the Douglas fir, one of the heaviest and strongest of Canada's woods. It has a fine, even grain, works easily under tools, is not prone to split, and has exceptional nail-holding qualities. In colour the wood is white, odourless and comparatively non-resinous.

THE helium plant, near Amarillo, Texas, designed, built and operated by the United States Bureau of Mines, Department of Commerce, produced 9,801,060 cubic feet of helium in the year ended June 30th, 1930. This was the first fiscal year of operation after the plant was constructed. Although the plant operated only ten months, having been closed in December, 1929, and February, 1930, for lack of orders for helium, the production was the largest ever turned out by the Government in one fiscal year, being about 800,000 cubic feet greater than the largest year's production of the Government's Fort Worth helium plant, which formerly supplied helium used by the Army and Navy. Even with this production the plant was operated at only a fraction of its present capacity, as it is capable of a production of 24,000,000 cubic feet per year. The cost works out at 17·25 dollars per 1000 cubic feet of helium produced.

As part of a general study of evaporation losses, the Petroleum Experiment Station maintaind by the United States Bureau of Mines and the State of Oklahoma at Bartlesville Oklahoma, has started a series of observations on bulk storage tanks. A group of five all-steel welded tanks, each tank approximately 10ft. in diameter and 20ft. long, with a capacity of 12,000 U.S.A. gallons, is being studied. Four of the tanks are equipped with 2 oz. pressure relief valves and ¼ oz. vacuum relief valves ; the fifth tank with a 5 lb. pressure relief valve and a ¼ oz. vacuum relief valve Of the four tanks equipped with the 2 oz. pressure relief valves, one is painted red, the second aluminium, the third is covered with aluminium foil—·004 of an inch —while the fourth tank is painted white and partly housed with asbestos sheathing. The fifth tank, which is equipped with the 5 lb. pressure relief valve, is painted aluminium. On each tank is mounted an instrument for obtaining a continuous record of the temperatures and pressures in the vapour space of the tank. Each tank contains approximately 8000 gallons of spirit. These tanks will be under study for about three months, during the hottest part of the year, when evaporation is greatest.

THE new home of the National Town and Country Club at Cleveland, Ohio, contains a large swimming tank fabricated completely by the electric arc welding process. This tank, which holds approximately 300 tons of water, extends from the fifth to the fourth floor of the building. It is 75ft. 8⅞in. long and 25ft. 7⅞in. wide, with depths at the two ends of 3ft. 8¼in. and 8ft. 8¼in. The deepest part measures 9ft. 8⅞in. Approximately 43 tons of steel was used in building the tank, according to the Lincoln Electric Company, which furnished the data for this note to the *Engineering News-Record*. The sides and floor are of ⅜in. steel plate, and the outside stiffeners are 6in. H-beams and 4in. I-beams. The bottom is supported by 18in., 20in. and 24in. I-beams which are part of the superstructure of the building. In fabricating the tank it was necessary to make 2400 linear feet of welds. The steel plates were lap-welded except at the corners and where the floor and wall meet. As an additional precaution against leakage and to secure further rigidity, the laps were welded on both sides. On the inside of the tank small squares of steel plate were welded in place 18in. apart. Steel rods were welded to these squares, both across the bottom of the tank and up the sides, in order to hold the finishing material in place. This consisted of a 4in. coat of gunite to which was cemented a tile lining

Miscellanea.

IT is estimated that the proposed bridge across the Tigris at Baghdad will cost £700,000.

IT is reported that the first 4½-mile section of the Buenos Aires underground railway will be opened this autumn.

IT is announced that the installation of a telephotographic service has been completed between Nanking and Berlin.

IT is estimated that the coal mines at Heigan on the left bank of the Sungari river in Manchuria contain 150 million tons of coal.

THE discovery of a deposit of lithium oxide is reported from South-West Africa. The ore is said to contain from 4·5 to 6 per cent. of the oxide.

THE new artificial silk factory of the British Bemborg Company at Doncaster, is to start work in December. The intended output is 9500 lb. of cupruammonium yarn a day.

WORK has just been started on the Abitibi Canyon dam in Ontario, which is to provide water for the development of at least 100,000 horse-power from a head of 237ft. The cost of the scheme is put at 23,000,000 dollars.

A TECHNICAL paper of the Building Research Board—No. 9—just issued by H.M. Stationery Office, price 6d., gives particulars of means of determining the amounts of hydrated and unhydrated lime in concrete mixtures.

A BENZOL recovery plant—Carbo-Union process—to be erected at the Beckton gasworks will be the largest in the world operating with active carbon. It will be capable of handling 75,000,000 cubic feet of gas per twenty-four hours, and will produce approximately 80 tons of benzol daily.

THE latest report of the Electrical Department of Mysore shows that the use of electricity in the agricultural area is growing in popularity, especially in connection with the driving of pumps. It is proposed to utilise the Jog falls for the development of some 40,000 horse-power.

THE last of the individual wires for the four 36in. cables of the Fort Lee suspension bridge in New Jersey has been laid in place. The work has entailed the handling of 28,400 tons of wire and will provide an open span of 3500ft. The spinning of the cables has been effected in 9½ months.

THE extent of the development of the hydro-electric power of Canada during recent times may be gauged by the fact that installations of over 1,660,000 horse-power are now under construction, and it is expected that there will be an addition of 2,000,000 horse-power when they are completed.

A NOTABLE character in the engineering world has been lost by the death of James Harvey Edwards, of the American Bridge Company, who died in New York on August 14th, after a very short illness It was he who contributed very largely to the present progress in the United States of welding as a structural process.

ON account of the increased importance now assumed by the British Empire Exhibition to be held at Buenos Aires in March and April, 1931, the Government have decided to treble the sum to be expended on its official participation. This increase will allow a considerable part of the British Govrenment exhibits in the Antwerp Exhibition to be sent out and adequately displayed at Buenos Aires.

THE Dover Town Council has rejected a proposal to draw its supplies of electricity from the Central Electricity Board, while the Edmonton Council has decided to hand over its powers for the electricity supply of the district to the London and Home Counties Joint Electricity Authority. As a consequence of the latter decision, the Council is to give notice of termination of the present agreement with the North Metropolitan Electricity Power Supply Company.

A NEW iron ore company has recently been registered in Sweden under the name of Jarna Gruvkoncern (the Jaerna Mining Concern). The new firm possesses valuable iron ore mines and deposits about 40 miles south of Stockholm, some of which were known and worked eighty years ago, while others have been discovered more recently. The iron content of the ore varies from 52·5 to 67·33 per cent., while the average percentage of phosphorus is 0·07 per cent. and of sulphur 0·15 per cent. The ore will be exported *viâ* a deep port on the Baltic coast at a distance of about 4 miles, which is to be connected with the mines by an overhead railway.

THE twelfth Model Engineering Exhibition which opened at the Royal Horticultural Hall, Westminster, yesterday, and closes on the 13th inst., is fully as interesting as its predecessors. A short tour of inspection left the impression that the amateur and professional modelling side of the exhibition is gaining the ascendancy over the toyshop section. In other words, the theory of the organiser, Mr. Percival Marshall, that model making has a real educative value, is gaining in favour. The models shown this year include several noteworthy examples, such as an exact scale model of H.M.S. "Hawkins," a very fine beam engine, an aeroplane engine and a little merry-go-round, with three rows of horses, that is said to include 3000 parts and is a most realistic representation that works as well as a full-sized machine.

THE British light car industry is placed at a decided advantage over all other outside competitors in the Spanish car market by reason of the increased tariffs recently introduced, for the new tariffs are calculated upon the weight of the vehicle, and the American manufacturers of heavy cars who have supplied most of the vehicles higherto imported into Spain, will be adversely affected. An instance of how some British industries are securing a larger share of imports into Spain is provided by the tire import figures for the first quarter of this year compared with those for the whole of 1929. British tire makers imported £64,141 worth of tires into Spain in the first three months of the year, whereas for the whole of 1929 their total imports were only a little higher, at £83,141. American importers, on the other hand, merely did their normal trade, importing £101,806 worth of tires, compared with £402,635 for the whole of 1929.

SUPER-PRESSURE BOILER AT BRADFORD POWER STATION

BABCOCK AND WILCOX, LTD., LONDON, ENGINEERS

(*For description see page 244.*)

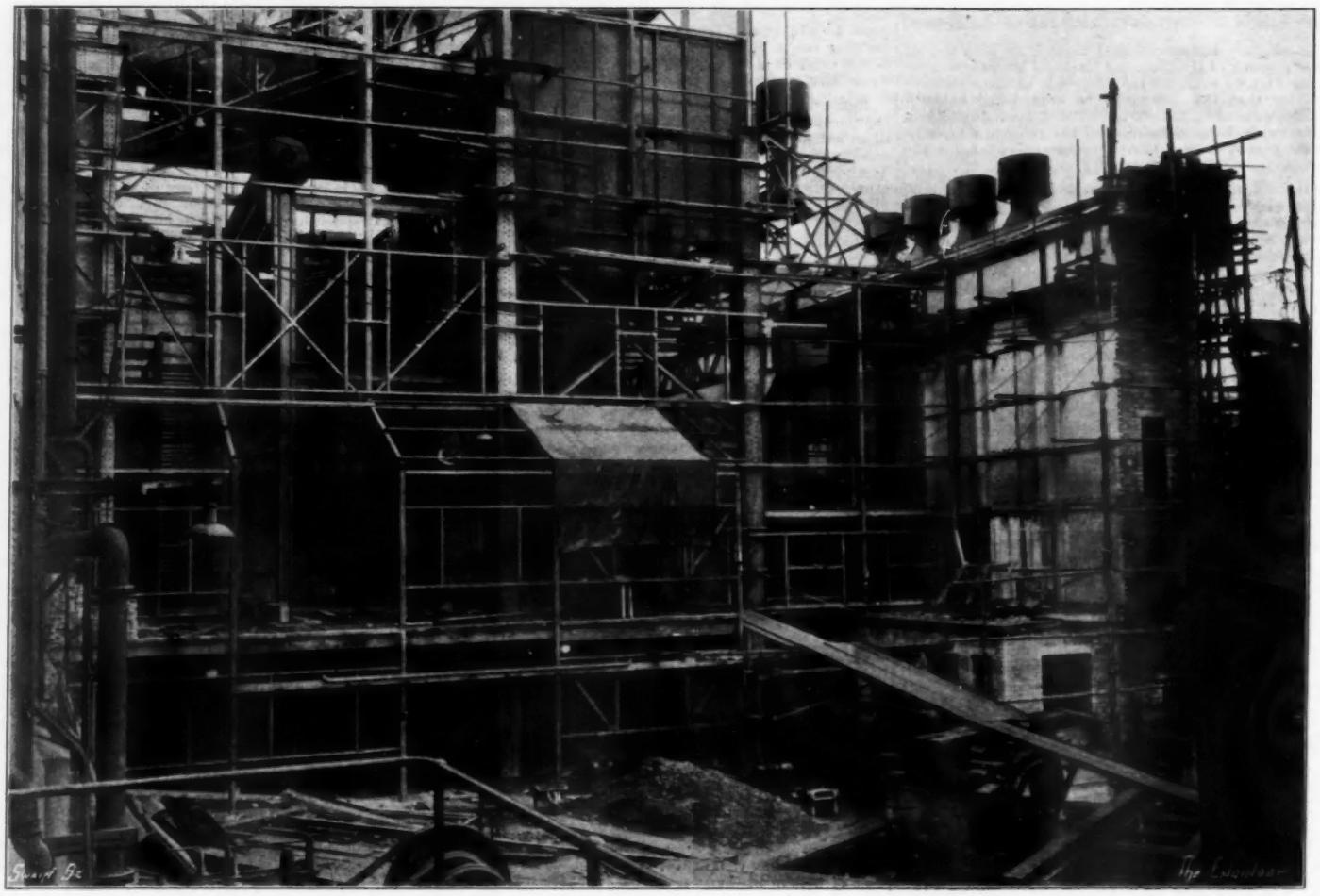


FIG. 9—GENERAL VIEW OF BOILER DURING ERECTION

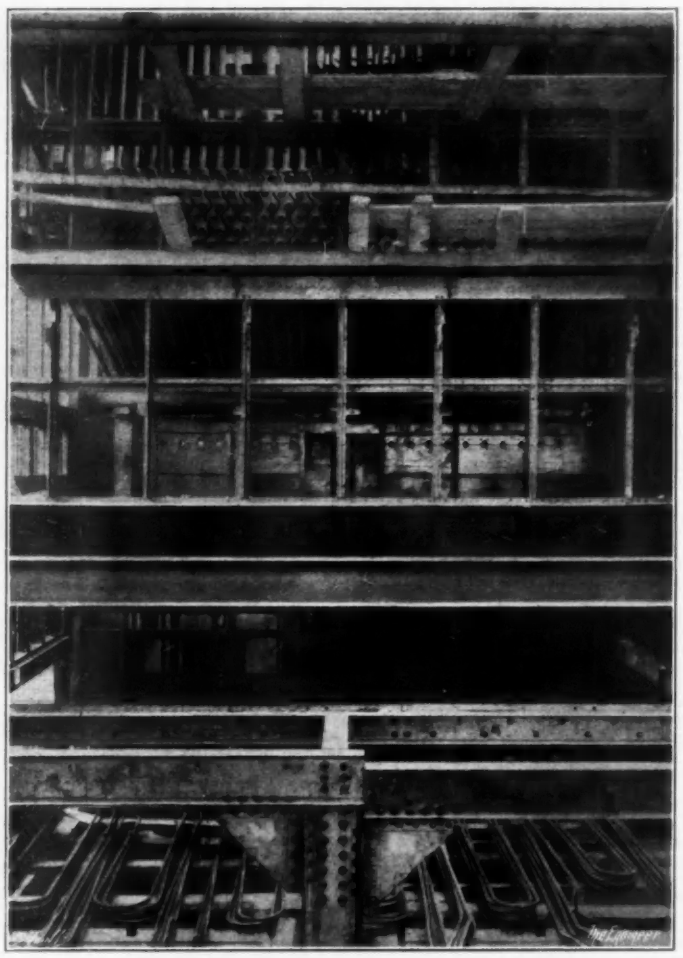


FIG. 10—FRONT OF BOILER DURING ERECTION

FIG. 11—AIR HEATER AND ECONOMISER

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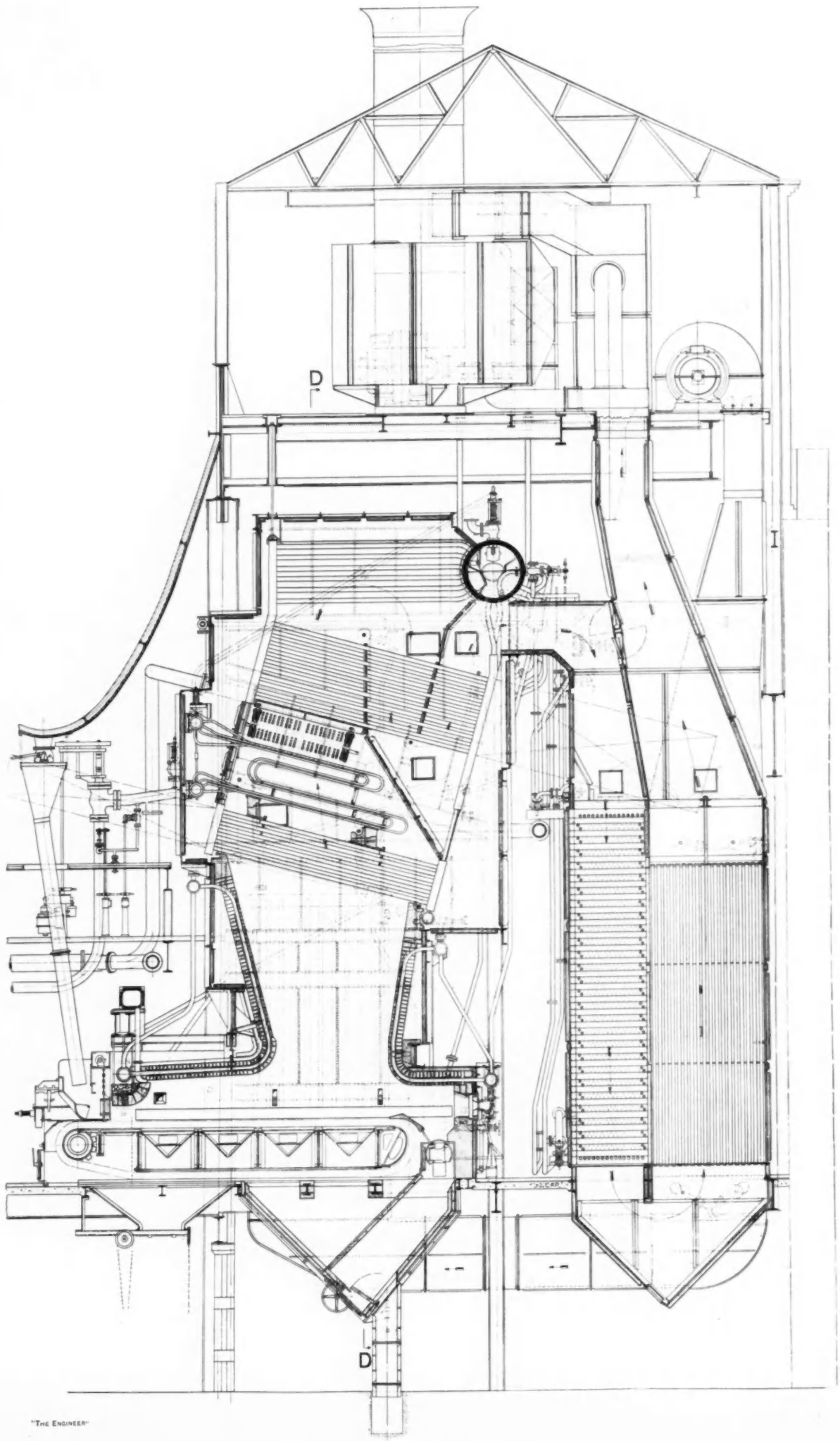

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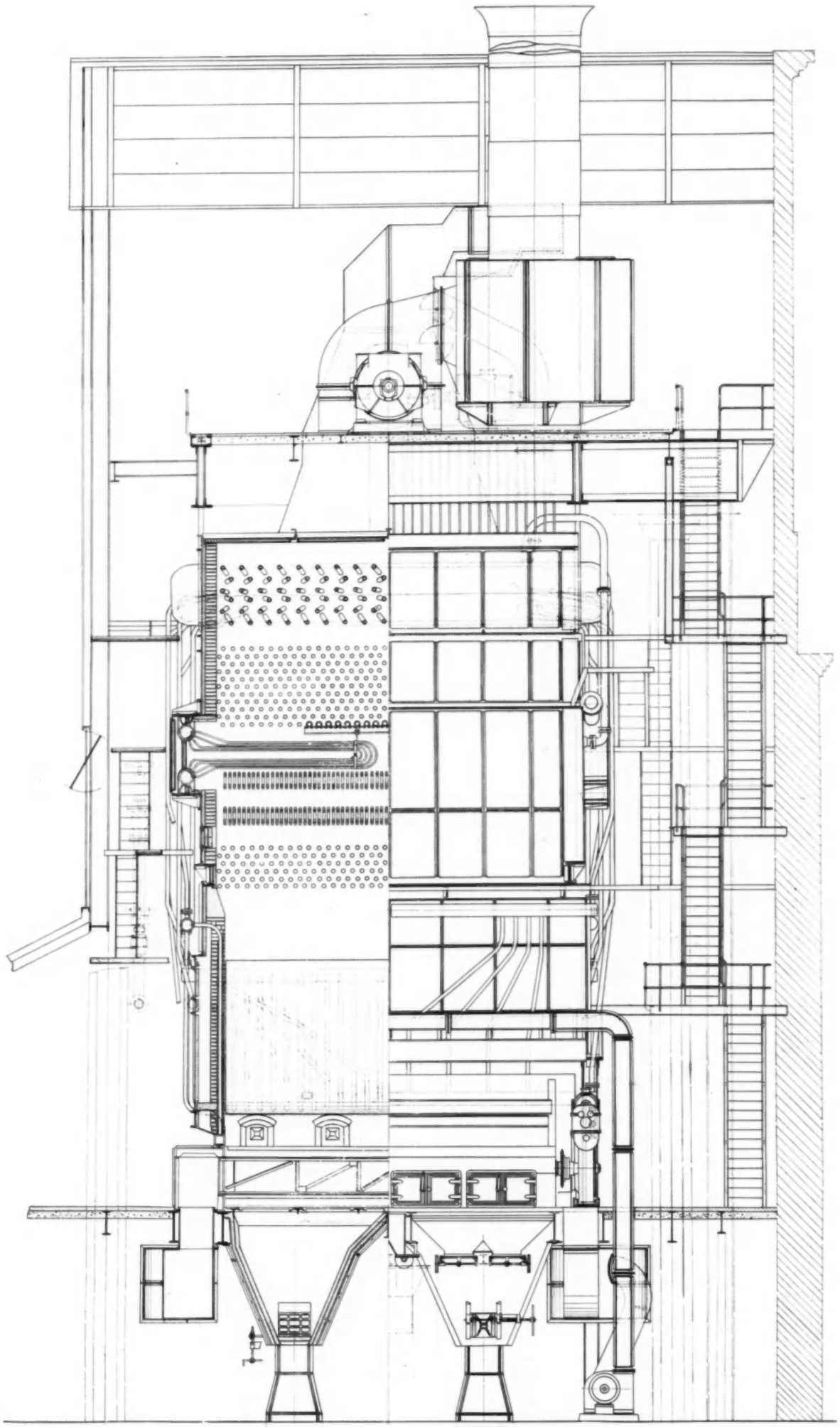

Section D.D. *Front View of Boiler*

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THE ENGINEER.

VOL. CL No. 3895

SEPTEMBER 5, 1930.

High Pressure Steam at Bradford.

THE description of the new boiler plant at the Valley-road power station of the City of Bradford, the first part of which we publish in this issue, cannot fail to interest all engineers concerned with power plant development. By adopting a pressure more than double that employed in any other power station in the country at the time and a temperature also well in advance of current practice, Mr. Roles showed a confidence in his own judgment and the City Council a confidence in their electrical engineer, which have given Bradford the credit of possessing a plant which marks noteworthy progress in design. At the time—January, 1927—the decision was made there appeared a real danger of British central station practice being outclassed by foreign developments. It is true that the Benson boiler, generating steam at the critical pressure of 3200 lb. per square inch, was first built and operated in England, but failing to find a congenial home here, the system was brought to maturity on the Continent. Except for this one, rather questionable, example, British enterprise as regards high-pressure steam seemed to have been almost wholly lacking since the far-off days when North Tees established a record with a boiler pressure of 475 lb. per square inch. Such a state of affairs was by no means creditable to British prestige. We were certainly developing power station practice to an exceptional degree of efficiency and reliability in the field of moderate pressures, but our neglect to explore the greater possibilities which theory held out to us in the use of very high pressures showed a disquieting lack of initiative. It was, moreover, bound to have an unfortunate repercussion on the business of our manufacturers. With plant for higher and higher pressures being demanded by foreign users, our makers of boilers, turbines, piping, feed pumps, superheaters, valves and fittings were all obviously handicapped. They could hardly hope to compete with foreign rivals who were able to point to work successfully carried out and who could place their manufacturing and operating experience so acquired at the service of their customers. Business goes to the firms which lead, and their enterprise is rewarded by a highly profitable market so long as they are known to hold the monopoly of experience in any new development. Conversely, the firms which have only made what anybody can make, must struggle for such orders as they can get, for, however great the excellence of their standard products may be, such firms are at a manifest disadvantage when tendering in a market which calls for goods in the manufacture of which they have had no experience.

This is a point which we would like to drive home. To succeed commercially we must at least retain, if not recover, the lead in design which we held a generation or more ago. It is a fatal policy for a firm to allow rivals to get ahead, and then to think it can acquire their experience by manufacturing their designs under licence. Even if it were possible to buy experience—which it is not—the firm which follows in design is necessarily behind. There is a story, which may well be based on fact, of a certain manufacturer who was known for his liberality in publishing details of his products and processes, and for the freedom with which he allowed his rivals to visit his works. When asked if he were not afraid that they would copy him, he replied that he wished for nothing better, because in that case he would always be two or three years ahead of them. The competitors he feared were those who originated things themselves. It is permissible to believe that a man so astute would lose no opportunity of persuading potential rivals to take out licences to use his designs, thereby ensuring that their position remained secondary and at the same time acquiring a useful revenue for himself. Much harm has indubitably been done to British engineering prestige abroad by firms, often against the advice of their technical staff, taking up the manufacture of foreign designs under licence, and thereby proclaiming to the world their distrust of their own designing capacity. The value of the cash tribute paid annually for licences to manufacture must be something very considerable, but far more serious is the position of inferiority which is tacitly accepted. How can a customer be expected to have confidence in the technical ability of a firm which does not possess such confidence itself. The position we would like to see would be that of British firms leading more generally in original design and acquiring the prestige and revenues which such a lead entails. It is easy to lay the blame on manufacturers when a lack of enterprise seems evident, but it is only right to be fair to them. Two parties are necessary to the realisation of every advance in engineering, one to give the order and the other to carry it out. Unless there are customers available for an expensive plant of a new type, makers can hardly be expected to develop it. In all progress, from the known to the unknown, there is a considerable element of risk, while with every step in advance the margin of efficiency for which the risk is run becomes smaller and smaller. Nevertheless, the risk has to be shouldered if any progress is to be made. Unless therefore engineers are to be found with the courage to stake their professional reputations on a course which they believe to be in the interests of their employers, the manufacturers may make designs and experiments for ever in vain.

We have wandered rather far from the Bradford plant, but the excursion has been legitimate. Bradford is an example of the enterprise we wish to see, a genuine effort by British manufacturers to demonstrate that they are able, from their own technical and manufacturing resources, to take their place amongst the pioneers of high-pressure and high-temperature steam plant. The whole installation, including boiler, turbine, and all auxiliary plant and apparatus, is of British design and British make, so that we have now had taken from us the reproach of having nothing of our own to talk about when very high-pressure steam is under discussion. That the plant will fulfil the anticipations of its designers we have no doubt whatever. We trust that it will even exceed them. But whatever its performance may be, its installation will have been more than justified by the lessons of design that it will teach. It marks, for the central station practice of this country, a definite step in progress, and all the manufacturers concerned in its production will henceforth be in a position to undertake with greater confidence the development of their particular apparatus. Mr. Roles and the Bradford Corporation, for their part, are likely to have the advantage of possessing a particularly efficient addition to their power station. They will have, moreover, the satisfaction of having accomplished something for the benefit of British industry. Their willingness to take a certain risk for the advancement of their

electrical undertaking provided the manufacturers with the chance to show what they could do. We hope that such opportunities will be multiplied. Before the war, the Admiralty was of immense indirect assistance to our shipbuilding industry by ordering faster and faster destroyers, and more and more powerful ships of the line. The experience thus gained by our naval architects and shipbuilders, and the prestige conferred on the industry by record performances, helped to keep our yards full of work on foreign account. More recently, the Government has signally assisted the electrical industry by the development of the "grid." Whether this will ever reduce the price of electricity to any appreciable extent is problematical. The benefit to the industry is not to be looked for in that direction. Nor do we refer to the temporary benefit to manufacturers of the apparatus comprised in the "grid." The really substantial advantage to the industry is the experience necessarily acquired in the development of large 132-kV transformers and aerial lines. British makers can now rely on achievements rather than on promises when competing for orders in connection with foreign high-tension transmission schemes. It is not given to many municipalities, and perhaps even less to private companies and individuals, to play a part comparable with that of a Government Department in fostering a new industry or in developing an old one. When such cases occur, therefore, credit should be given to the courage displayed, as it now ought to be given to Mr. Roles and the Bradford Corporation.

Diesel.

WE have been searching our memories for a parallel to the use of "Diesel" as a generic name for injection oil engines, and have failed. No one speaks of a condensing engine as a "Watt," or a high-pressure engine as a "Trevithick"; we do not describe the locomotive as a "Stephenson," every steam turbine as a "Parson," or the self-inductive dynamo as a "Wilde." Why, then, should every internal combustion engine which happens to compress clean air instead of a charge be called a "Diesel"? Some true Diesel engines are built to-day. They retain the characteristics of the original design, particularly the injection of the charge by a blast of air compressed by the engine itself. But the type is going out, and by far the greater number of heavy-oil engines now employ pump injection and dispense with the separate compressor which was a feature of Dr. Diesel's design. The majority of them, in fact, have no resemblance to that engine, save the compression of pure air which was invented and used by Ackroyd-Stuart before Dr. Diesel's time. It is true that Dr. Diesel claimed also the high temperature of compression as a means of igniting the charge, but since earlier engines employed automatic or surface ignition with which the timing of the explosion depended upon the compression, the same principle was virtually in use before Diesel adopted it.

Probably very many of those who use the word without ever thinking of its true connotation have never read Dr. Diesel's patent specification of 1892, and it may therefore be worth while to reprint the claims. There are only two of them, and they run as follows: (1) The method of working combustion motors consisting in compressing in a cylinder by a working piston, pure air, or other neutral gas or vapour together with pure air, to such an extent, that the temperature hereby produced is far higher than the burning or igniting point of the fuel to be employed, whereupon fuel is supplied at the dead centre gradually, that on account of the outward motion of the piston and the consequent expansion of the compressed air or gas the combustion takes place without essential increase of temperature and pressure, whereupon, after the admission of fuel has been cut off, the further expansion of the body of gas contained in the working cylinder takes place, substantially as described. (2) The mode of carrying out the process referred to in the preceding claim with multiple compression and expansion by providing the combustion cylinder on one hand with a compressing pump and reservoir, and, on the other hand, with an expansion cylinder, or by coupling several combustion cylinders with each other or with the said compressing pump and expansion cylinder, substantially as described.—It will be observed that the first of these two clauses describes part of an internal combustion engine cycle, the second the means of carrying it out. As a matter of fact, it was the engine itself, rather than the part-cycle, which made the inventor's reputation. We may indeed doubt, in view of the Hornsby-Ackroyd engine and the Ackroyd-Stuart patent, that the first claim could have stood alone. But in nearly all modern engines which are misnamed "Diesel," there is an almost complete departure from the inventor's practical design, and the only similarity that remains is the high compression of pure air or pure air with some admixture of burnt gases. If we analyse the matter further, we find that in the compression of pure air or a neutral mixture, priority must be awarded to Ackroyd-Stuart, and the only item in the part-cycle that remains to Dr. Diesel's credit is the abnormally high compression, with, of course, the accompanying high temperature. These considerations bring us once more to the conclusion that the high honour which rightly belongs to Dr. Diesel is due on account of the engine itself, and if a radical departure is made from the fundamental details of the inventor's design, the name "Diesel" is wrongly applied.

We believe the definition "Diesel" has been retained merely as a convenience, though it is known that for a time it had a trading value. In 1922 a committee of the Institution of Mechanical Engineers endeavoured to define the various cycles of internal combustion engines in a convenient form. It found it practically impossible to do so. The phrases became cumbrous and awkward, and none of those that were considered by the committee have come into common use. To get over the difficulty, the word "Diesel" has been retained, but as the progress of invention has taken modern engines further and further from the German prototype, we would urge engineers no less than the general public, to refrain from the indiscriminate use of a word which is not accurately descriptive, and the retention of which does some injustice to a prior inventor. Furthermore, we suggest that it would be a real convenience if the word "Diesel" were retained for those engines, and those alone, using air blast fuel admission, and that when other means of injection are employed they should be described in some appropriate way—solid injection, airless injection, &c.—but without the use of the word "Diesel."

Æsthetics in Metal Bridge Designs.

By W. NELSON ELGOOD, B.Sc.

LESS than a century ago engineers began to consider seriously the economics of metal bridges. Since that time metal bridge designers have been subjected to severe criticism from the general public for producing so-called ugly structures. The general public, who are the final judges of the æsthetic qualities of a structure, can appreciate a beautiful design, and will, if the occasion permits, give credit to the creator. In what way do metal bridges fail to give pleasure to beholders? A modern British express locomotive or one of the large Atlantic liners is viewed with delight, and pride is felt in living in an age which produces designers whose genius is, among other things, refreshing. With the exception of a few notable exceptions, metal bridges are condemned as works of utility without the qualities necessary to render them æsthetic structures.

Before attempting to consider the factors which govern æsthetics in the design of metal bridges, it is necessary to have a clear idea of what is meant by beauty in a structure. An analysis of such beauty reveals that it can be readily divided into two components, namely, poetic grace and artistic grace. In poetic grace the beholder is able to obtain an instant impression of the functions of the object viewed. This impression gives a pleasure, but that pleasure is not complete. In viewing an express locomotive, the functions of speed and of drawing power are instantly, and perhaps unconsciously, realised. This impression is not one of completed pleasure; it is one of gloating pleasure. In artistic grace it is the lines of the object viewed that give pleasure. In viewing a modern British express locomotive the beholder's pleasure is completed, for not only are the functions immediately realised, but the general appearance as given by the lines makes the requisite additional appeal to the mind. The combination of poetic grace and of artistic grace makes a design æsthetic.

In some structures the lines have not been introduced for the purpose of giving artistic grace; they are the result of evolution in design. In other structures the lines are purposely embodied in the design to render complete its æsthetic appearance. In metal bridges the cantilever, the arch, and the suspension structures possess beautiful lines that are obviously the result of evolution in their designs. The Forth Bridge, which at its birth was an economical design, ranks as one of the most beautiful structures in Great Britain. On the other hand, bridges consisting of a number of girders and trusses do not as a rule possess in the economic designs artistic grace. The Tay Bridge possesses poetic grace, and on viewing it one experiences a gloating pleasure, but not a complete pleasure. It is in the design of girder and truss bridges that the general public sees so much to criticise.

In this discussion we must confine ourselves to those bridges designed in accordance with scientific principles. It is barely seventy years since bridge designers left the age of rule-of-thumb and entered the present period of ordered reasoning. In the rule-of-thumb age a number of bridges with no poetic grace were erected. To cite an example, in those days trusses were built with a depth less than that considered as necessary in modern practice, and beholders from the general public obtained an impression of insufficient strength. Bridges erected in the present period of ordered reasoning have been designed in accordance with the prevailing scientific and economic principles, and gradually a number of types have been evolved which are in general use and which possess the required poetic grace.

In designing a structure, an engineer not only considers the probable capital cost, but the equivalent total first cost. Now the latter factor, which is the sum of the capital cost and the capitalised value of the annual recurring costs, must not only be a minimum for the different designs that can be made for the structure, but it must not exceed the capitalised value of the expected annual gross revenue. It is beside the point here that in most bridge projects the true revenue is unseen, being hidden in the benefits obtained by users and others. Usually a bridge is not directly revenue producing. Any sum expended in first cost in excess of the amount given in the minimum equivalent total first cost is an extravagance. If the estimated amount of the gross revenue is sufficient to allow of extravagant expenditure, then such expenditure, if made, can only be justified if utilised for the purpose of giving an artistic grace to the structure.

In laying out a bridge the designer has to apply the law that states that for economical design the cost of the piers and the abutments must equal the cost of the spans without the floor systems. A design will, therefore, consist of a number of spans, the designs of which are determined by considerations of economics. In the evolution of bridge spans certain types have been selected as the most economical for different lengths under different conditions. Thus, plate girders may be the most economical for span lengths of 25ft. to 75ft.; Warren trusses for spans of 75ft. to 100ft.; Pratt trusses for spans of 100ft. to 175ft.; other trusses with polygonal top chords or with subdivided panel lengths for spans of 175ft. to 350ft.; and so on. In addition, for larger spans, the arch, cantilever or the suspension structure may prove the most economical for the conditions and the specifications. The bridge designer finds that the general design of his bridge is determined entirely by the economics of the case. He has not a free hand in selecting the type of bridge for the project.

As mentioned previously, the arch, cantilever and suspension structures usually possess poetic grace and artistic grace, and consequently the lines of the respective designs do not require modification. In a design consisting of, say, a series of plate girders and trusses on tubular steel piers, however, artistic grace is usually absent in the economical design. In a case of this nature, if the expected revenue justifies it, extravagant expenditure can be made to improve the lines. If such extravagance cannot be justified, the designer has the misfortune to be criticised for his work ably performed, and the general public is disappointed.

The improvement of the lines of a bridge is not an easy task. Embellishments in the nature of cast iron rosettes plastered over the members of the spans are useless and the addition of false units and members which take no load and carry no stress is, under no consideration, permissible. Golden rules cannot be laid down to effect required improvements. Each bridge project presents its own particular problems for solution, and it is seldom that two bridges require similar treatment.

The arch, the cantilever and the suspension bridge have polygonal members which give an impression of curvature. Curves harmonise more readily with nature than do straight lines, and a structure with such lines does not appear too incongruous in its setting. To be æsthetic a bridge should not enter the vision of a beholder too abruptly—that is, it should not appear as a mass of metal which does not in some way or another run into the surrounding topography. The writer has learnt of the appearance of a bridge that was considerably improved by continuing the parapets beyond the abutments and running them into the side hills at the entrances of cuttings which were near the abutments. Previously the parapets ended abruptly at the abutments and the appearance of the bridge was ruined by no attempt being made to run it into its surrounds.

It is impossible here to enumerate the many improvements which have been carried out by designers as true extravagances. At times simple remedies have effected the required result. Oftentimes, the batter of masonry piers can be modified to give a more harmonious appearance; too great or too small a batter can ruin appearance. An adjustment of the span lengths to obtain uniform incremental increases in length from, say, the abutments to the centre will please a receptive mind, and even equal incremental increases between the abutments

and the centre in the longitudinal dimensions of the ties and struts in the bracing of a truss undoubtedly improve the artistic grace. Simplicity in design assists more in obtaining an æsthetic appearance than is realised; a single intersection truss has better lines than those of a multi-intersection truss.

A differentiation must be made between true and false extravagances. Such differentiation may at times be difficult to determine. As a general rule, false extravagance may be regarded as the addition of useless members or units to a structure for the purpose of giving it artistic grace. True extravagance is a modification of the designs of members and units to obtain the desired artistic effect. In the past, bridges with false extravagant additions have been built in this country, with the result that they are now pointed out by engineers of other countries as monuments to extravagance. False extravagance made solely for the purpose of improving the lines of a bridge cannot be tolerated. Architectural treatment of the elevation of a bridge sometimes results in the addition of false extravagances, but oftentimes these additions are made for a second purpose, such as giving an impression of the commercial wealth or industrial progressiveness of a city. A favourite method of doing this is by adding heavy masonry pylons. Additions of this nature should not be included in the design of the bridge proper, for they are not integral parts of the bridge; their cost should not be included in the capital cost of the bridge, they should be covered by funds from another vote.

Since the dawn of intelligence man has built bridges for utility purposes, and during the evolution of man's mind an appreciation of the æsthetic appearance of a bridge has appeared. It is only within comparatively recent years that iron and steel have proved to be suitable materials for certain types of bridges, and it is possible that evolution in some designs has not progressed far enough to produce structures with an artistic grace comparable in mental impressions effected with that of a modern British express locomotive. The fortunate designer who finds himself in possession of sufficient funds to enable him to make true extravagant expenditure does his best to add artistic grace to his design if it is necessary. His less happy colleague who works with a bare allowable first cost deserves the commiseration of all; through no fault of his own he produces a structure which is scientifically and economically correct, but which is universally condemned by the harsh critics as ugly, and by the kind as un-æsthetic.

Literature.

A Condensed Outline of Modern Physical Chemistry. By FREDERICK HURN CONSTABLE, M.A., Ph.D., F.I.C., F.I.P., F.R.A.S., &c. London: Benn Brothers, Ltd. 1930. Price 10s. 6d.

THIS book is stated in the preface to be "a logical sequence of chapters written in a highly compressed form," ostensibly to replace tables. It is to be observed that the author gives no definition of physical chemistry, and that is probably a wise course to take, as the bulk of that science deals with solutions of no interest to a chemist and with simple physical operations which are elementary to the physicist. As a matter of fact, the solutions are confined to dilutions at which the dynamical theory of gases or the law of mass action can be applied without disgracing themselves. Four pages are given to the application of thermo-dynamics to strong solutions, which reiterate the principle of maximum work as determining equilibrium whilst going back to Helmholz, evidently referring back to the original, as the symbol A is used for work—German: *Arbeit*.

The book starts with ostensibly a dynamical theory of matter, which mainly refers to the dynamics of gases. This extremely difficult and highly debatable department of physics is treated in the usual dogmatic way as dealing with fully established truth—in 22 pages. The intention of the author seems to be to establish the accepted formulæ *inter alia* for the mean free paths of gas molecules, their diameters and numbers per unit of volume as giving definitely true results with a few simple assumptions only. Curiously enough, one of these assumptions is that the masses of the molecules do not affect one another, or, in other words, that for the purpose of this theory gravitation is left unconsidered. That has always been the stumbling-block to mathematicians, and the reviewer remembers well how the late Professor Sylvester of Oxford raised the point during a series of long private conversations in 1893, when he contended that the molecules of a gas must eventually fall to the bottom of the containing vessel unless heat was something else than the kinetic energy of the gas molecules. The quantum theory has lately come to the rescue; but the quanta are endowed with mass, though exceedingly small, thus only prolonging the procedure.

The author's treatment of the chapter is fairly easy to follow, and the notes on work done by an ideal gas during expansion with its application to osmotic pressure of solutions, is almost elegant, considering the bearing it has on Nernst's and Planck's work in electro-chemistry. With regard to the calculation of the number of molecular collisions per unit of time, the author has taken the results as absolute, though they are actually probabilities becoming true, when the total number of collisions is infinite. Probabilities governed by some function of π are very interesting, and the reviewer might mention one of a simple nature illustrating the point. If you rule a sheet of paper with parallel lines, and then throw a straight wire, the length of which is half the distance between the lines, haphazard on the paper a number of times, then the total number of throws divided by the number of times the wire touches a line will gradually approximate the value of π. The proof of this class of probability is rather beyond the understanding of the public school-boy mentioned by the author in his preface, and he has, as stated above, followed the usual practice of dogmatising. As a matter of fact, the results are only approximative, as can be seen from the values of molecular diameters, calculated from effective molecular volume according to Van der Waal's and from the mean free path respectively—page 22. For hydrogen, for instance, the values are $1{\cdot}27\times10^{-8}$ and $1{\cdot}36\times10^{-8}$ at ordinary pressure, and hydrogen under diminished pressure at all events is the most ideal gas we know. If we now proceed to the finding of the expression for C_p/C_v—pages 17–18—the author is not quite as lucid as elsewhere. At the bottom of page 17 he says: "If each molecule has energy expressed by n terms *in addition* to the three representing the energy of translation, the energy function takes the form"—then follows an expression, which means that the total energy is equal to the translatory energy and energy quantities, one for each atomic linking in the molecules, which he calls internal energy. Well, on page 18 he gives quite correctly—

$$C_p/C_v = 1 + \frac{2}{3+n}$$

Then there is a misprint, $n=2$ instead of $n=0$, for mono-atomic molecules, making $C_p/C_v=1{\cdot}66$. For di-atomic molecules he makes $n=2$ for *one* linking, which he stated would be in addition to the translatory energy, hence n might mean the total number of terms in the expression on page 17, taking the three terms of translatory energy as one. Even then n ought to be unity for mono-atomic molecules, which it is not, or else he assumes two energy quantities for one linking, which seems the most probable; but from the general expression used on page 17, viz., $\frac{1}{2}\,a\,\varphi^2$, nobody can tell, and some elucidation ought to be given. The exceptional values given by the author have their explanation in the fact that the *molecular* linking is a function of the temperature, besides which ionisation may play a part in the case of gases like chlorine.

Taken on the whole, one must doubt the advisability of the author's extreme brevity in treating the subjects, and the above remarks are only general examples of how the reader might be puzzled. Admittedly, the whole first chapter belongs to general physics, and students of physical chemistry, for some reason or another, do not always take physics as a subject, and the dynamical theory of gases is essential for understanding osmotic pressure and the correlated conceptions in electro-chemistry, &c. &c. Modern research at high pressures and high and very low temperatures has, however, so utterly modified the conceptions of the gas laws that inculcating a belief in the young mind that they are a kind of infallible gospel is almost criminal. The learning from books of the type under review creates mental sterility, and the application of physical chemistry of the kind generally advanced in the bulk of this book does not lead to the advancement of science.

When Arrhenius added the electrolytic dissociation theory to the theory of osmotic pressure in 1885 and 1887, the theory of solutions dilute enough to satisfy that theory was complete, and during more than forty years students all over the world have amused themselves with taking freezing points and boiling points, measuring electrical resistances of more or less tainted water, &c., which could give figures according to theory for publication, but nobody has as an example made any serious attempt at finding out what type of function actually governs the variable, which at extreme dilution becomes the dissociation constant, by systematic study of more concentrated solutions. Such is the soporific effect of making theory a fetish by book learning.

It has to be noted that the method of determining molecular weight from freezing point depression was formulated by Raoult without reference to theory, and that other practical uses of orthodox physical chemistry are confined to isotonic solutions, &c., in physiological chemistry. The author cannot be blamed for all this as long as universities everywhere want schematic knowledge for examinations, and he does give the essentials of the various chapters quite concisely as desired. It would be impossible for the reviewer to enter into the details of the separate sections or to point out the many misprints. (The hydrate $NaCl_2$, $2H_2O$, for instance—page 34—seems to want some explanation as well as how 94,300 —68,000 gives—page 27—alternately 26,000 and 26,300.)

Amongst the best parts of the book is the treatment of the law of mass action—pages 63–77—where the author has allowed himself more elbow room. Electro-chemistry is given four pages, the phase rule just over two, &c. &c., and there are chapters on colloidal and surface chemistry, catalysis, and the structure of atoms, and photo-chemistry. The strictly mathematical form of the treatment of the subject matter renders this compression feasible, but involves a great deal of work on the part of the reader, and to keep the whole together in the mind requires more than ordinary intelligence. And this is the rub: unless you keep on refreshing knowledge of this kind, either by teaching or incessant reading, it becomes evanescent. If the student, on the other hand, studies the phenomenology in the laboratory and associates each formula with an actual experiment, he will easily remember where to find the desired formula for another similar experiment, and then a more elaborate book or set of books is preferable.

This book will no doubt have its circulation amongst those for whom it was specifically written. The reviewer has no reason to find fault with it as a memory refresher for advanced students or graduates, but what is a student "taking open scholarships at Oxford or Cambridge" supposed to know according to the author? On page 139 he gives without any explanation Einstein's formula for mass as a function of velocity, which also involves that velocities higher than that of light cannot exist. One must conclude that according to the author the relativity theory, from which this particular formula is derived, is an ordinary subject in secondary schools, or else that the student must take the truth of the formula on the author's authority. Just this class of teaching has made modern scientific development into speculative metaphysics, supported by speculative mathematics and written authority, which must eventually lead to chaos. The real advance has been made by empirical research, and by the application of ordinary three-dimensional mathematics to electricity and optics according to the nineteenth century undulatory theory.

SIXTY YEARS AGO.

ON September 2nd, 1870, Napoleon III. and 80,000 of his troops surrendered to the Prussians at Sedan. Two days later the second French Empire ceased to exist. Bazaine, commander-in-chief of the Emperor's forces, was invested at Metz. Paris lay open to the enemy and, under a Republican Government of National Defence, was hastily preparing to withstand a siege. It had all happened in a month. On August 2nd the French had been victorious in a minor engagement at Sarrebruck on the enemy's side of the frontier. By September 2nd the whole organisation of the French Army had been crushed to death. In all countries there was a reaction to these great and pregnant events. In Britain it took the form of an almost unanimous demand for the creation of a great army. Our weakness in the field became an obsession with the daily Press. We were a ready prey for the spoiler, it said. If we would be safe we must be strong, and our strength, it was argued, should, as events across the Channel showed, consist of soldiers and more soldiers. To-day it seems almost incredible that such an opinion should have been advanced at a critical moment in the history of this sea-girt nation, or that attacking it, as we did in our issue of September 9th, 1870, we should be able to describe as comparatively novel the view that our real strength lay on the sea. It should be remembered, however, that within ten years Prussia with her land armies had swiftly crushed, first, Denmark, then Austria, and now France. Had the Franco-Prussian war produced a single naval engagement, the state of popular opinion in this country would doubtlessly have been different. As it was, the generation then alive had come to maturity in an era during which land power seemed to be everything and sea power at the most a useful auxiliary to it. We vigorously attacked the popular standpoint. Britain, we said, to be safe, must be able to do two things—keep off invaders and protect her Colonies and commerce. No standing army, militia or volunteer force which we could possibly sustain could prevent invasion. To secure that end an overwhelming naval force was essential. Six hundred men in an ironclad could do more for the defence of the country than six regiments of the line at full strength. Only two nations existed which were likely to give us trouble—America and Prussia. It would be years, we said, before France thought of invading us. We pictured an attempted landing of 100,000 men in this country at some quiet spot, such as Sandgate, Herne Bay, Margate, Bournemouth, or Folkestone. Nothing we could do would prevent invasion if our ships were defeated or kept engaged by a more powerful fleet. But if our ironclads remained supreme the enemy's transports would be sunk, buried and destroyed in an hour if they were unarmed. If the enemy used warships to transport his troops he would find it impossible at one and the same time to engage our warships and shore batteries and to land troops in boats. The most helpless and unmanageable creature in existence was a soldier, especially a foreign soldier, in a boat. Probably seasick, certainly wretched after the passage, the invading army would be comparatively helpless. Troops so landed would, in fact, simply be thrown away. It was to our fleet and its crews that we must look for national safety and for the avoidance of a disaster such as that which had befallen France. Our policy should be, not to attempt to protect every portion of our coast, but to do as Nelson did, to watch the enemy's shores and never to let a hostile fleet out of port without the certainty of a naval engagement. The policy which we outlined was not only exemplified by Nelson, but was the basis of the vast national effort in which we ourselves have taken part. It seems strange that midway between Trafalgar and Jutland there should have been a time when the general public of this country required urgently to be told wherein lay Britain's real source of strength.

Two new torpedo-boat destroyers are being laid down at Portsmouth Dockyard next month.

Opposed-Piston Heavy-Oil Engines.

No. I.

THE present position of the heavy-oil engine is an especially interesting one, and among the many and varied proposals for obtaining efficient combustion and satisfactory operation the Junkers design is particularly noteworthy. We are indebted to Messrs. Trost Brothers, 104, Victoria-street, Westminster, S.W. 1, the representatives in this country of the Junkers-Werke, Dessau, for the following account.

The opposed-piston heavy-oil engine with return connecting-rods is, it is interesting to note, a direct descendant of the Oechelhaeuser and Junkers opposed-piston gas engine. Professor Junkers, when a young man, worked with Oechelhaeuser, and as far back as 1890 began to investigate experimentally on the opposed-piston gas engine the questions of high ratios of expansion, reduction in heat losses to the walls, and efficient scavenging. The advantages of the opposed-piston engine from the point of view of combustion, led him to consider various mechanisms of this type, and from the beginning he has employed a single crank shaft with return connecting-rods from the "upper" pistons.* An exception to this arrangement, however, occurs in the latest development, the aircraft engine, in which, for reasons of lightness, the two-crank shaft arrangement is employed.† The first heavy-oil engine working on the opposed-piston principle was built in 1908, and from that time, with the exception of the war period, development work has been confined to heavy-oil engines of this type working on the two-stroke cycle.

The advantages that are claimed for this design fall, chiefly, under the two headings, mechanical and thermo-dynamic. A comparison between a two-cylinder opposed-piston engine with return connecting-rods, working on the two-stroke cycle, and a four-cylinder single-piston engine of conventional design, working on the four-stroke cycle, will assist in making the former clear. This is a correct comparison, since, assuming equal power outputs and piston and revolution speeds, the crank-effort diagrams, with two impulses per revolution, are exactly similar. Now, since a single impulse on the opposed-piston engine is divided between two pistons, the cylinder diameter, when compared with that of the single-piston engine, will be in the proportion of $1 : \sqrt{2}$. The pressure loadings on the running gear are thus also in the proportion of $1 : \sqrt{2}$. Allowing for the return connecting-rods, and assuming three main bearings to each crank shaft, the corresponding lengths of the engines are approximately as 3 : 4. With this arrangement, the height of the opposed-piston engine is greater by the length of stroke of one piston, together with the space occupied by a piston and a scavenging pump—the plunger of the scavenging pump is usually integral with the upper crosshead. In this connection, it should not be overlooked that the stroke/bore ratio of *one* of the pistons of the opposed-piston engine is greater than that of the single-piston engine in the proportion of $\sqrt{2} : 1$.

It is interesting, also, to compare the dynamical balance in these two cases. As concerns primary balance, the four-cylinder engine is balanced as regards forces, but, with the usual combustion order of 1–3–4–2, there is a considerable primary couple to be taken by the crank shaft and frame. In contrast to this, each cylinder of the opposed-piston engine can be completely balanced. The secondary out-of-balance forces of the opposed-piston engine are considerably less than those of the single-piston engine, since the connecting-rod crank ratio of the upper pistons is more than twice as large. The secondary couples, too, are further reduced in proportion to the lengths of the crank shafts.

In the single-piston engine, too, the pressure forces acting upwards on the cylinder covers are transmitted as longitudinal tensile stresses in the cylinders. With the opposed-piston arrangement, the longitudinal pressure forces are imposed solely upon the running gear, the cylinder not being subjected to direct longitudinal stresses. With the relatively smaller diameter of the cylinder the stresses set up in the liners by the internal fluid pressures are proportionately reduced. Since the same power is produced in half the number of cylinders, there is a corresponding reduction in the necessary piping, nozzles, fuel pumps, &c., a distinct advantage from the point of view of upkeep.

Before considering the advantages of the design from the point of view of the thermo-dynamic efficiency, the method of working will be briefly described. Fig. 1 shows two sectional views of a two-cylinder engine—actually the lorry engine, 2 HK. 80—from which the arrangement of the cylinders, pistons, connecting-rods and crank shafts can be readily understood. This arrangement is common to all engines of the Junkers design, with the exception of the aircraft engine. The plunger of the scavenging pump forms the upper crosshead, its area being such that the swept volume of the scavenging pump is more than twice that of the pistons. The pump draws in air on the down stroke, and compresses and delivers it on the up stroke, the valves being spring-loaded and automatic. The inlet ports are at the top and the exhaust ports at the bottom. The sequence of operations in the engine is shown diagrammatically in Fig. 2 in the views A to D, the latter showing the connecting-rods. In Fig. 2 A the pistons are shown in their inmost positions, the plunger of the scavenging pump being then at its lowest point. Fuel is being injected into the air compressed between the pistons, and new air is being drawn into the scavenging pump. Fig. 2 B shows the state of affairs just after exhaust has begun. The crank for the lower piston is set a little earlier than that of the upper piston, and the lower piston has already uncovered the exhaust ports, the flow of gases in the cylinder being downwards. At this point the plunger of the scavenging pump is near the top of its stroke, and air is being forced through the delivery valves into the engine body or crank case casting, which serves as an equalising chamber and is always under pressure. In Fig. 2 C the instant shown is a little later, *i.e.*, after the upper piston has uncovered the inlet ports. Owing to the earlier opening of the exhaust ports, the pressure in the cylinder is reduced towards that of the atmosphere, and, under the pressure in the crank case, the scavenging air flows with high velocity into the cylinder, expelling before it the remaining exhaust gases. The inlet ports are arranged so that the inflowing air enters the cylinder tangentially, and the whole mass of air in the cylinder thus acquires a vortex swirl. This swirling action not only ensures efficient scavenging, but, in addition, plays a dominant part in the process of combustion. The exhaust ports close somewhat earlier than the inlet ports, and thus permit of a building up of pressure in the cylinder, above that of the atmosphere, at the instant when the inlet ports close. Compression of the air in the cylinder brings the cycle of operations to the point shown in Fig. 2 A. Owing to the displacement of the lower piston into the crank case at the same time as air is being delivered to the crank case, there is no actual passage of air through the crank case—which would naturally lead to excessive oil consumption—but the volume of the crank case is utilised only for equalising the scavenging pressure.

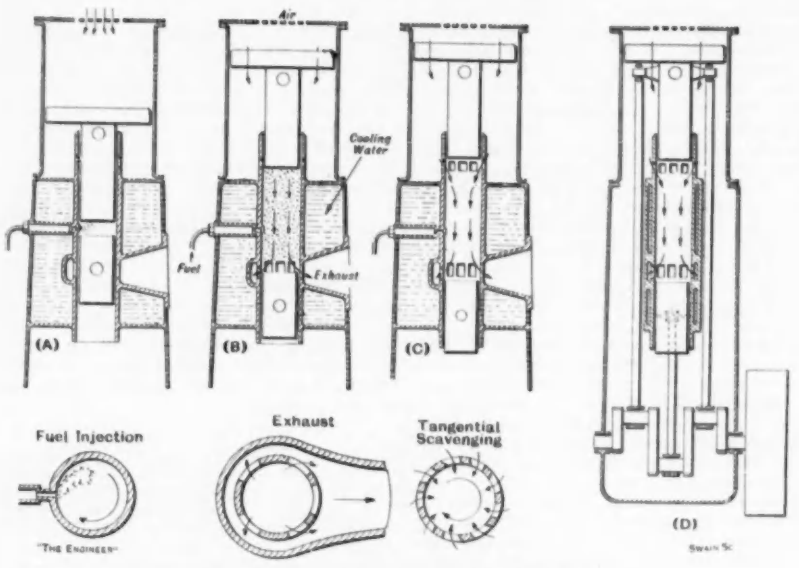


FIG. 2—OPERATION OF JUNKERS ENGINE

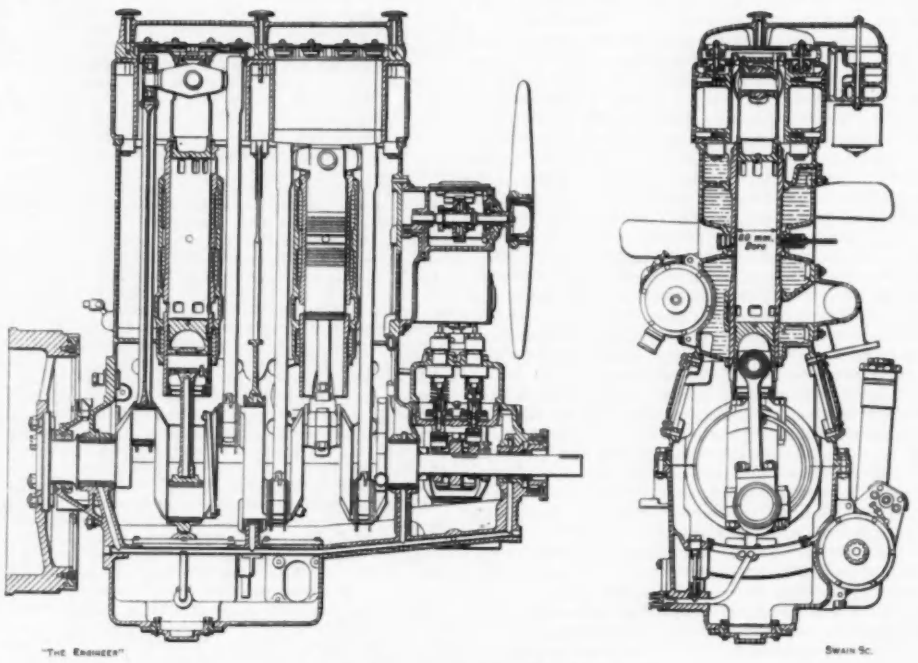


FIG. 1—HEAVY-OIL LORRY ENGINE

The process of combustion can be followed from Fig. 4. There are only slight frictional resistances to the swirl of the air about the axis of the cylinder, referred to above, and thus, the cylinder and pistons being plain, this swirling action will be sustained throughout the compression stroke. So that when the fuel is injected into the combustion chamber, as indicated at A in Fig. 4, the motion of the air is orderly and rotational in character. The fuel is led from the supply tanks to the pipe B, and through filters to the float chamber C, which ensures a constant level of oil, and thence to the fuel pump D. The fuel is forced by the pump through the double non-return delivery valve E to the open nozzle F. The design of the fuel nozzle is especially ingenious, and is shown in detail in Fig. 3. L is the outer casing, coned internally, and provided with a small hole. The fuel is led through the centre of M to the small passages at the coned end, which fits accurately into L. From these passages the small slots on the outside of the cone of M then constitute further passages through which two small streams of fuel are led to the hole in L. These streams impinge together in the hole and produce a flat fan-shaped spray, as shown in Fig. 4. The plane of this flat spray is set at a small angle to the transverse plane of the cylinder, so that the particles of fuel are distributed regularly through the rotating air.

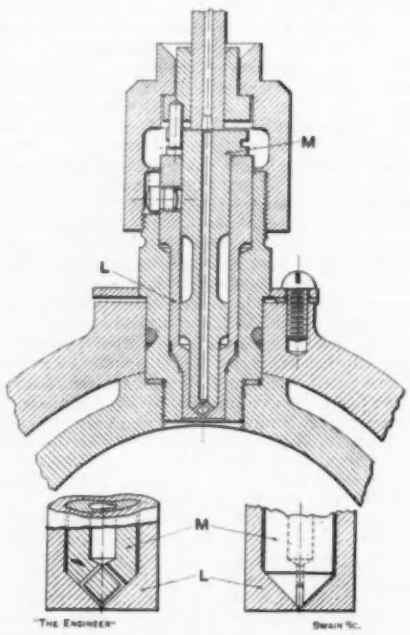


FIG. 3—FUEL NOZZLE

Referring again to Fig. 4, it will be seen that the plunger

* This development work is described in detail in the "Jahrbuch der Schiffbautechnischen Gesellshaft," 1912.

† Gasterstaedt, Wiss. Ges. für Luftfahrt. Jahrbuch, 1929.

of the oil pump receives its motion from a cam, which, since the engine works on a two-stroke cycle, is carried on the main crank shaft. The motion is transmitted through a roller on a rocker arm to a tappet, which acts directly on to the plunger. The plunger is naturally spring-loaded to retain contact with the tappet. The rocker arm is mounted on an excentric which can be actuated by the lever J. The lever has two principal positions: In one, the pump is

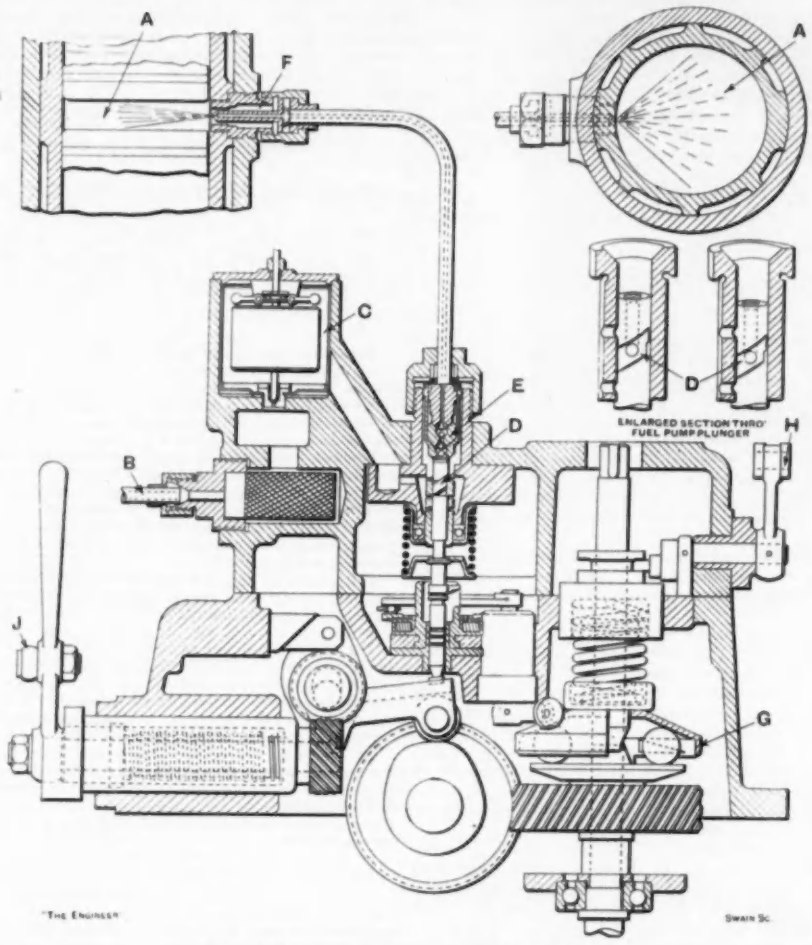


FIG. 4—FUEL PUMP AND FUEL REGULATOR

in operation as when the engine is running; in the other, the roller is raised from the cam, and the engine is at rest. If the lever be worked to and fro by hand, with the engine at rest, the pump is actuated, and the pump, piping, and nozzle may be readily primed.

The action of the pump is explained by the enlarged section through the fuel pump plunger reproduced to the right of Fig. 4. The fuel oil flows from the float chamber to the two holes shown at the side of the pump cylinder. The pump plunger is hollow down to the slot cut across it. So long as this slot is opposite neither of these holes, and the plunger is moving upwards, oil is being delivered by the pump, but no oil is delivered if the slot registers with either hole. Thus, with the plunger moving at a suitably high velocity, the lower edge of the slot is arranged to pass the lower hole; this is the instant at which pressure is set up in the system and injection begins. Delivery of oil continues until the upper edge of the slot registers with the upper hole. The contours of the edge of this slot, combined with the angular position of the plunger about its axis, will determine the instants of the beginning and end of the injection process. This angular position is naturally correlated with the position of the governor.

The governor, shown at G in Fig. 4, is mounted on a vertical shaft driven by helical gearing from the crank shaft—incidentally, it may be noted, this vertical shaft also drives, from its lower end, the lubricating oil pump. The centrifugal governor is of simple design, the rotating weights being large bearing balls. These press against the lower curved surface of a cone, their upward reaction, when the engine is running steadily, balancing the downward force exerted by a simple helical spring. The vertical position of this cone determines the angular position of the lever, which, in its turn, controls the angular position of the pump plunger and thus the process of injection. The tension of the governor spring can be directly regulated by the lever H, so that the equilibrium speed of the governor, and therefore of the engine, may be arbitrarily controlled; the governor controls the speed at this setting in accordance with the load on the engine.

From the point of view of combustion the opposed-piston engine has marked advantages. The elimination of the valves, and particularly the hot exhaust valve, leads to a lower mean temperature of the air at the beginning of compression, and a correspondingly higher volumetric efficiency. The absence of cylinder covers, with their extensive water-cooled surfaces, is naturally a further favourable circumstance. With the efficient scavenging which follows from the simple form of cylinder and from the uni-directional flow of the gases, the two-stroke cycle may be profitably employed. The stroke/bore ratio with two pistons is exceptionally favourable; as a result, assuming a compression ratio of the usual order, the form of the combustion chamber, a cylinder of quite appreciable height, is such that the surface is very small with relation to the volume; and, further, the proportion of the surface that is water-cooled is, at inner dead centre, very small indeed. Thus, from the standpoint of heat losses to the walls during compression, combustion and expansion, the design shows a marked superiority over the conventional single-piston engine. Apart from heat losses, too, the compact form of combustion chamber makes for an ordered movement of the air and a better control of combustion, with an enhanced thermal efficiency.

Bearing in mind the advantages, both mechanical and thermo-dynamic, which follow from the Junkers design,

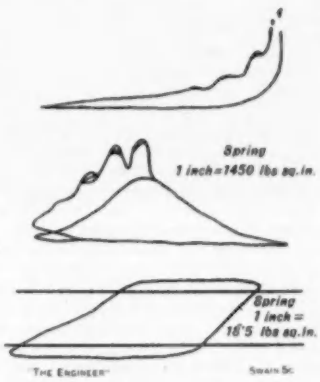


FIG. 7—INDICATOR DIAGRAMS

it is not difficult to understand that it has been successfully applied to engines for an extremely wide range of purposes. The Doxford marine oil engine, whose performance is well known in this country, has been successfully developed and adapted to marine purposes by Wm. Doxford and Sons, Ltd., from designs made originally by Professor Junkers' close collaboration between the two firms being broken by the war. This engine may be cited as an example of the use of the design for slow-running engines developing a high power per cylinder. Under the present control of the Junkers Company the engines being built, directly or under licence, range from the HK. 400 type, of 400 mm. (15·75in.) bore, with an upper piston stroke of 440 mm. (17·31in.) and a lower piston stroke of 660 mm. (26in.), designed to develop 1050 B.H.P. when running at 215 r.p.m., shown in Fig. 5, through engines of decreasing cylinder diameters and increasing speeds of revolution, to that shown in Fig. 1, the 2 HK. 80, the two cylinders of which are of 80 mm. (3·15in.) bore and the designed normal speed 1100 r.p.m. with a normal output of 45 H.P. A still smaller size is produced, the 1 HK. 60, with cylinder bore 60 mm. (2·36in.), developing 8 H.P. at 1100 r.p.m.

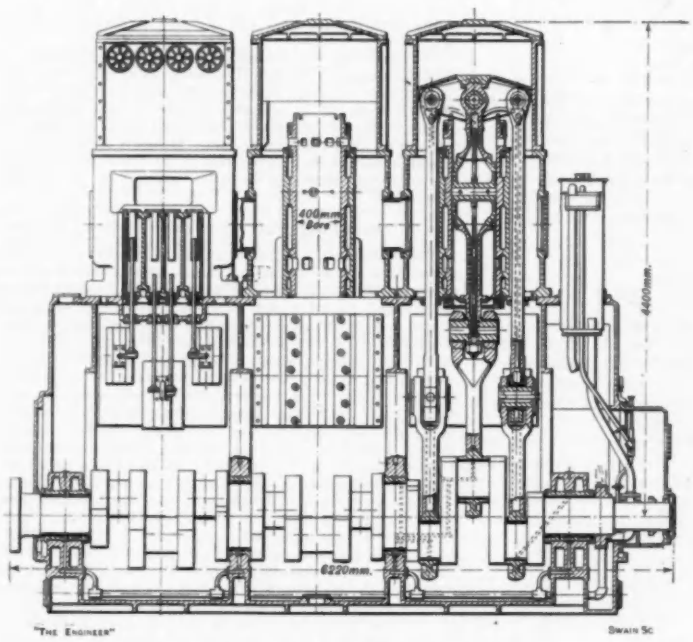


FIG. 5—1050 B.H.P. STATIONARY ENGINE

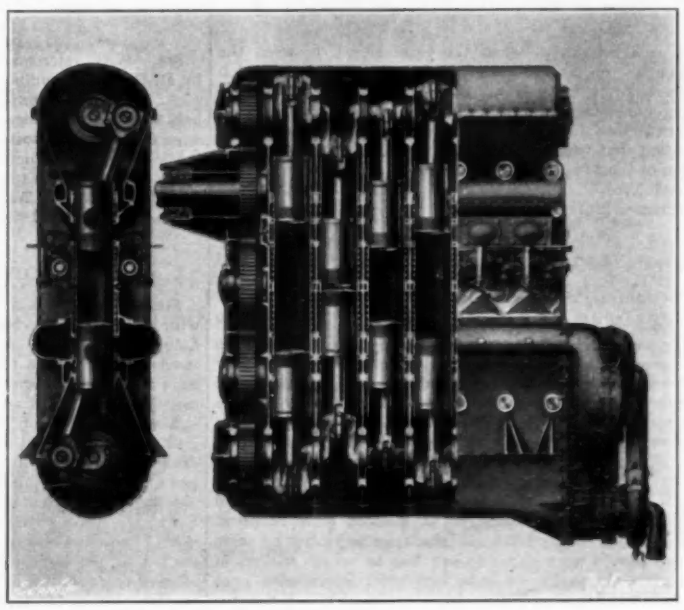


FIG. 6—HEAVY-OIL AIRCRAFT ENGINE

Typical indicator diagrams from the working cylinder and the scavenging pump of one of these small high-speed opposed-piston engines are reproduced in Fig. 7. The brake mean effective pressure was 87 lb. per square inch, the speed 1182 r.p.m., giving 9·4 B.H.P.* These engines all have the same general arrangement of the

* Neumann Z.V.d.I., August 9th, 1930.

moving parts, being single-crank engines with return connecting-rods, and having the plungers of the scavenging pumps integral with the upper crossheads. They have been applied in practice to drive dynamos, pumps, air compressors, both stationary and portable, workshop and other machinery, motor boats, locomotives, agricultural machinery, dredgers, cranes and lifting appliances. All can be readily supplied having any practical number of cylinders. In addition to these, the opposed-piston principle has been applied to the design of the Junkers aircraft engine shown in Fig. 6. This is arranged, for reasons of lightness, as a two-crankshaft engine, and scavenging air is supplied in this case by a turbo-blower. It has made several successful flights and, in view of the invaluable experience for its further development which has already been gained, it will shortly be placed on the market.

(To be continued.)

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

TENSILE STRESS IN BOLTS.

SIR,—A delusion, common among machine designers, as to the nature of the tensile stress in bolts, is well illustrated by the following case which recently came under the writer's notice.

Failure occurred in the bolts attaching the big-end cap on the connecting-rod of a reciprocating engine, and the assumption was at once made that these bolts had failed by fatigue under repeated tensile stress.

On this assumption, a series of elaborate tests was undertaken, in which similar bolts, tightened in special adaptors designed to reproduce the conditions of the connecting-rod and cap, were mounted in an electro-magnetic testing machine and subjected to a repeating tensile load P estimated from consideration of the engine performance.

The bolts withstood an indefinitely large number of repetitions and were removed at the conclusion of the test without any sign of fatigue. This result could have been predicted; in fact, the tests were a waste of time.

The tensile load W on the bolts is estimated from consideration of the spanner torque applied in tightening the nut, the form of the thread and the coefficient of friction between the nut and bolt threads and between the underside of the nut and the face of the connecting-rod cap on which it bears.

When the nut is tightened, this load W subjects the bolt to an elongation

$$\frac{W\,l}{a\,E}$$

where a is the cross-sectional area of the bolt, E is the elastic modulus and

$$l+\frac{W\,l}{a\,E}=L$$

the length between the underside of the nut and of the bolt head when the connecting-rod and the cap are in contact.

Unless the repeating load P exceed W, no further elongation can be produced and the stress in the bolt must therefore remain *constant*.

But P must not be allowed to exceeds W, otherwise the bolt would be subjected to a further elongation

$$\frac{(P-W)\,l}{a\,E}$$

at each repetition, when the total length between the underside of the nut and of the bolt head would exceed L above, and therefore hammering would be set up between the connecting-rod and the cap.

It follows that the tensile stress in bolts must, as a rule, exceed that which the designer estimates from consideration of their function in the machine, a fact which is often overlooked. H. P. SPRATT, B.Sc.

Science Museum, South Kensington, S.W. 7,
August 26th, 1930.

RURAL ELECTRIFICATION.

SIR,—In the issue of your paper dated August 8th of this year, under "American Engineering News," there is a paragraph headed "Rural Electrification." Your correspondent states that 625,000 farms in the United States are receiving electric service from high-tension transmission lines at a cost of 2½d. per horse-power hour, as compared with 7½d. per horse-power-hour from small local power stations, or 1s. per horse-power-hour from an individual plant on the farm.

It is the last statement that we are particularly interested in. As your correspondent is dealing with America, we are not in a position to challenge anything he says, even should we wish to do so; but as we are makers of crude oil engines, we have first-hand information concerning the cost of generating electric current by means of these. It is, as a matter of fact, well known that in this country, under favourable load conditions, a modern crude-oil engine will develop 1 electrical unit—which we are taking to be approximately equivalent to 1 horse-power-hour from the user's point of view after loss in generator and motor are taken into account—for a cost of ¾d. for fuel and lubricating oil.

We have before us as we write, the report on "Heavy Oil Engine Working Costs, 1928–29," issued by the Diesel Engine Users Association, London. This report shows that the average total overall cost of generating electric current in all the heavy oil engine installations under review, in this country, is ·640d. per kilowatt-hour, and this is a figure obtained by stations working mainly under very unfavourable load conditions.

We hope you will, therefore, excuse our pointing out the enormous discrepancy between the figure of, say, ¾d. per kilowatt-hour and the figure of 1s. Surely the independent power plants referred to by your correspondent must be extremely inefficient, and the cost of generating by means of them rather misleading to the public.

We have supplied engines in cases where the customer was previously using electric current at between 2d. and 3d. per unit, and the saving has been sufficient to pay for the cost of the engine inside one year. It does not seem to be generally realised that electric current must be supplied at a very cheap rate indeed to show economy even equal to that obtained from a modern crude oil engine.

For ALEXR. SHANKS AND SON, LTD.,
JAMES SHANKS, Director.

Arbroath, August 28th.

THE LOSS OF THE "CAPTAIN."

SIR,—I was deeply interested in reading the note published in your issue of August 8th on the much-debated question of responsibility for the loss of the turret warship "Captain" and the causes which led to that disaster in the month of September, 1870.

There are, I think, very few people alive now who saw that ill-fated vessel, and, among that few, I can be included. I saw the ship a number of times while she lay in one of the Birkenhead docks, having the finishing touches put to her by her builders. I was twenty-three years old at that time, and I can recall to memory most of what I saw as well as if it had occurred yesterday.

I did not fail to observe her small freeboard, and it seemed to me, viewing it as I did from the quayside, even less than the figure mentioned in your journal. I judged it at the time as about 5ft., though that low estimate appears to have been wrong.

Another thing I remember, and which impressed me, was that the vessel was fitted with masts and yards of considerable dimensions, and that feature also had my particular attention, though it was not until after the event that it occurred to me that they were without question a strong contributory cause of the vessel capsizing. Anyway, it does not need much imagination to understand that with a wind of any appreciable force striking her on her beam it would be the final factor which led to her turning over.

I am under the impression that the "Captain" was the first turret ship built for the British Navy, and her being built was largely due to ideas inspired by the famous American war vessel the "Monitor," which fought with the Confederate ironclad vessel "Merrimac" in the Civil War in the years 1861 to 1865. There was, however, this radical difference between the "Captain" and the "Monitor." The "Monitor" had neither yards nor masts, and the only projections above the level of her deck were her turret and her smoke funnel.

If I may be allowed to express an opinion, I should say, from what I observed, that if the "Captain" had been without her very heavy top hamper of masts and yards and sails she would have been passably free from the risk of capsizing. OCTOGENERIAN.

Hampstead, August 26th.

COHESION.

SIR,—With reference to the article on "Cohesion," by R. Douglas Archibald, D.Sc., in your copy for August 15th, in which he expounds the theory that matter is held together by magnetism, I would call attention to a very beautiful exposition of this theory in the book on "The Natural History of Crystals," by Tutton, where many beautiful diagrams of this theory are shown.

THOS. H. WEBSTER, A.M.Inst. C.E., Wh. En.

Glasgow, August 18th.

LOCOMOTIVE No. 123.

SIR,—I note that in your last issue you chronicle the withdrawal from service of engine No. 123 of the former Caledonian Railway. As you consider this remarkable old machine worthy of a reference, you may be interested to have some details regarding her from one who was closely associated with her during her youth.

I was in the Hyde Park drawing-office when she was built and had a hand in some of the minor details of her drawings. I was then kindly allowed to take a hand on her erection, in company with Mr. Andrew Reid under erector W. Forsyth. When she was completed, I ran with her to the Princes-street Goods Station in Edinburgh and spent two days and a night in the streets while she was hauled to the Exhibition. When she came out, I was allowed to run trials, first from Glasgow to Perth and then on the Perth–Dundee service, at that time one of the few trains timed at nearly 60 miles per hour. After the breaking in was completed, we were put on the Glasgow and Edinburgh fast service, and during running I was called on the carpet by that grand old man Mr. Dugald Drummond for sitting out in front oiling a hot piston-rod, my pass being taken away and only returned against a promise to stay in the cab. We were then put on to run the morning fast from Edinburgh to Carlisle, while the Glasgow section was run from Glasgow to Carlisle by the four-coupled engine fitted with Bryce Douglas valve gear, No. 124, built by Dübs, which had also been in the Exhibition. It was a race to get to Carstairs first and get the road to Carlisle. At Carstairs as we passed through we were relieved to be signed to that we were ahead, and we got to Carlisle doing the run, if my memory serves me, in 103 minutes. We waited minute after minute for our rival, which, however, had broken a link in the motion and came in many minutes late on one side. That was my farewell to the famous old machine, though I saw her several times in the course of years on my return from service in India. I do not suppose that with a load of 160 tons there ever was or will be her equal for speed and comfort, nor do I believe that more careful or honest work was ever put into any engine.

P. A. HYDE.

Westminster, S.W. 1, September 2nd.

Oil-Paved Runways for Air Ports.

WE reprint below, in abridged form, an article, written by Mr. J. A. Herlihy, which appeared in a recent issue of our contemporary the *Canadian Engineer*. Mr. Herlihy is the Chief Engineer of Transcontinental Air Transport, Inc., of St. Louis.

Rapid increase in air traffic in the past few years has brought forcibly to mind the necessity of paved runways for air ports. The purpose of this paper is to point out the necessity for such runways and to describe the methods of building them, with particular reference to the use of asphalt pavings.

The two main reasons for the necessity of paved areas are, first, to ensure the operation of heavy transport planes during wet weather, and, secondly, to eliminate the dust nuisance so long associated with air ports. This latter item, together with the smooth landings and take-offs possible on paved runways, is very important to passenger-carrying air lines.

It is obviously impracticable to consider paving or surfacing the entire area of an air port. The natural solution was to surface certain areas of the field called taxiways and runways.

The size of these runways has been a subject of much discussion. For runways which are to be used as take-off strips only, 90ft. is ample width. For landing strip the runways should be at least 120ft. in width. It is true that under ideal conditions a pilot can land his plane on a very narrow runway, but if there is a cross wind, if one tire is flat or if one brake should stick a little, 120ft. is about as narrow as it is safe to use. Then there is also the problem of turning the ships around on the runways. Again, under ideal conditions, a pilot can brake one wheel and turn very sharply, but in a strong wind it is difficult to handle planes on the ground.

LENGTH OF RUNWAYS.

The length of runways required varies with the altitude above sea level. They do not in general need to be the full length of the field, but at sea level, where the Department of Commerce requires 2500ft. of clear field, the paved area should be at least 1500ft. of that length. At 5000ft. above sea level the Department of Commerce requires runways about 4000ft. long, but 2500ft. of paved area is ordinarily sufficient.

There have been as many different methods of air port surfacing as there have been of highway surfacing. These include gravel, sand-clay, cinders, oil and asphalt pavements of all types and concrete. In this paper only the oil or asphalt pavings will be discussed.

Properly designed asphalt paved runways will easily support the weight of the heaviest transport planes and give a smooth, resilient, dustless surface. They are not prohibitive in first cost, and are easy to install and maintain.

The chief objection to oiled runways is their colour. For night landings, the problem of properly lighting an air port having oiled runways is more difficult than if they were of a light colour. If an asphaltic compound of a light sand or cream colour can be developed it will be a real step forward in air port runway paving. If white strips about 4ft. in width are built at the borders of the runways, it will help materially in offsetting the light absorption of the black pavement.

DIFFERENT TYPES OF OILED RUNWAYS.

There are many different types of oiled runways, each suited to a special purpose. Hard, smooth pavements are desirable for taxiways and areas near passenger stations, &c. Hard runways are also very desirable as take-off strips, but for landings, a softer, more resilient surface is desirable. The Grand Central Air Terminal at Glendale, California, is an example of a field with separate take-off and landing strips. The take-off strip is of concrete, 3000ft. long and 72ft. wide, flanked on both sides by a strip of asphalt 12ft. in width. The landing area is approximately 400ft. wide and 3500ft. long. It is made of a 4in. mixed-in-place "plastic mix" oil pavement. This arrangement is very satisfactory. If a runway is to be used for both landings and take-offs, it should be fairly soft and resilient.

Extremely hard runways are very hard on aeroplane tires, which, of course, have to be built as light as is consistent with safety anyway. Consider a plane coming in at 55 to 60 miles an hour and the force which is necessary to start a wheel 40in. in diameter weighing 92 lb. instantly spinning at the rate of 500 r.p.m. Obviously, the wheel cannot start spinning at that speed instantaneously and there must be a give, either in the tire or in the pavement. If the pavement is too hard it will burn the tire severely at the instant of contact and greatly shorten the life of the tire. If you stand near a plane landing on a hard runway you will hear a sharp shriek as the tire comes in contact with the runway. Softer landing strips of the plastic mix type are, for this reason, far preferable for landing areas. Another point to be considered is that small ships, equipped with tail skids, which ordinarily prevent ground looping, are apt to get in serious difficulty on a hard pavement.

The methods of producing the harder pavements are the same as used in highway work and will not be discussed in this paper. The softer, plastic mix landing strips offer a

slightly different problem, however, and a description of how those were built on several fields in the south-west will be described.

MIXED-IN-PLACE METHOD.

The method in general was as follows:—The runways were made by the "mixed-in-place" method. In other words, the oil and the soil were mixed in place on the ground. The method is readily adaptable to desert country having fine sandy soil containing not too much organic material nor containing more than a trace of calcium sulphate or sodium sulphate, which have a detrimental effect upon the oil, causing it to lose its binding properties. The process was used on a wide variety of soils.

The first process is to analyse the natural soil, which should show a fairly uniform grading from 200 mesh up to ¼in. If the natural soil is not properly graded it will be necessary to bring in foreign material of such a size as to make a uniform grading of the mix between the limits given above.

The thickness of the runways will depend entirely upon local conditions. If its function is almost entirely dust protection and there is no problem from rain with the possibility of bogging down the plane, then about a 2in. cake will be sufficient. If it is necessary to build a runway which will hold up under heavy rains, it should be about 4in. in thickness.

The runway is prepared for the application of the oil by a thorough harrowing with a disc harrow, thoroughly mixing the natural soil with the foreign material, if it is used. After mixing the soils the oil is applied through a force-feed spreader in separate applications, of approximately ¼ gallon per square yard. The oil used was a 60–70 per cent. asphalt oil of 80 penetration at 77 deg. Fah. After each application the runway is again harrowed to thoroughly mix the oil and soil. Ordinarily, it will take about three-fourths of a gallon of oil per square yard per inch of thickness of runway. The finer the material the more oil will be necessary.

After all of the oil has been applied it is mixed by blading it back and forth across the runway with an ordinary blade grader set at an angle about 45 deg. with the direction of travel. This blading serves to thoroughly mix the oil and the soil and is a very important part of the process. It will ordinarily be necessary to blade the mix from twenty to thirty times to get a thorough combination of the materials. In wide runways, it will be advisable to blade the material up in windrows about 15ft. apart and then blade it back and forth. When the material is thoroughly mixed it will have a dark chocolate appearance in the windrow and will be thoroughly uniform in colour. The mixture should be live and tend to crawl when disturbed with a stick or other instrument.

The next process is to lay the material down on the surface in a layer of uniform thickness. This is done with a straight blade and will require very careful work to get a good job. After it is laid down it should be rolled with a light roller or preferably by a truck with large pneumatic tires. This will give a seal to the surface as well as compact the material underneath. It will probably not be advisable to use a heavy roller, which would be liable to leave waves in the surface.

Care should be taken not to apply any oil while the materials are wet nor attempt to do any mixing while they are wet.

These runways will give a smooth, tough and resilient surface, excellent for the landing and taking-off of aeroplanes. If material not over ¼in. in size is used, they will remain fairly soft, permitting ships with tail skids to land comfortably with little danger of ground looping.

If harder runways are desired they could be obtained by using coarser material, say, up to 1in. in size. We made runways this way on one of our fields and they have set up very hard, similar to macadam roads.

* * * * *

The methods described will work very well in the dry south-western country. For northern and eastern fields it will be necessary to put in a much more substantial base with the plastic mix material in a layer 2in. to 3in. thick on top. The proper drainage of such fields and runways is, of course, of primary importance; however, the scope of this paper does not permit of a discussion of this subject.

The present trend in air transportation is toward larger and heavier planes, which will make the paving of runways on air ports even more necessary than at present. . . These runways should be of two classes: the hard-surfaced taxiways and take-off strips and the softer more resilient landing areas. Asphalt oils readily lend themselves to the building of both of these types of air port paving.

Devices for Handling Awkward Heavy Articles.

THE drums used for carrying heavy electric cables or wire ropes are awkward articles to handle and transport. It is claimed, however, that the difficulties which have hitherto accompanied the handling of them have now been surmounted by the special lifting truck—illustrated in Figs. 1 and 2—which has been developed and placed on the market by the Transporting Machinery Company, Ltd., of 76, Victoria-street, Westminster, S.W. 1.

The frame of the truck is constructed of rolled steel sections and flats, riveted together, and is in two parts. The lower portion, which is fitted with three wheels, forms a travelling carriage, on the front cross beam of which is mounted a steel casting that is bored to receive a vertical pivot which connects the handle to the front wheel bearing bracket. This vertical pivot also carries a horizontal pin which serves as a fulcrum for the handle, and the lower end of the handle, by engaging with a lip attached to a jacking mechanism within the casting previously mentioned, acts as a lever to operate the mechanism and raise the load.

The upper portion of the framework carries steel brackets, upon which can rest the spindle of the cable drum. These brackets are adjustable for height, and a graduated scale allows horizontal alignment to be maintained. The upper part of the frame is connected to the lower portion by hardened steel links and pins. In the lowered position of the machine these links are nearly horizontal, but when the jack is operated they assume a position more nearly vertical, thus raising the upper frame and with it the load. Between the two frames are mounted two oil dashpots, one on each side, and when it is required to lower the load the operator lightly presses a small trip lever with his foot, whereupon the upper frame, restrained by the dashpots, sinks gently to the lower position, thus depositing the drum on the ground.

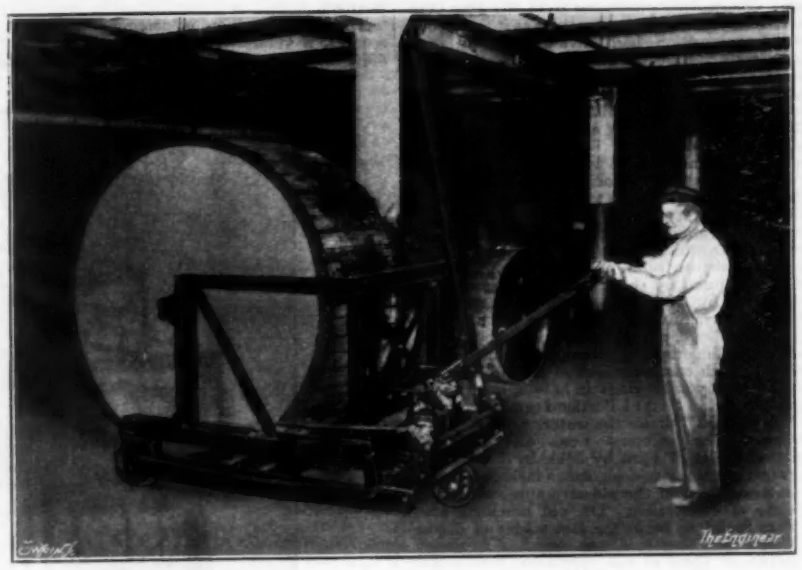


FIG. 1—LIFTING TRUCK CARRYING CABLE DRUM

The makers draw special attention to the mobility of the truck, which, they point out, is due to the disposition of the front wheels. The latter, which are 12in. in diameter, are slightly inclined towards each other so as to make for easy steering. The rear wheels are made 4in. wide on the rim so as to ensure stability when the truck is travelling. The wheels are drop forgings and are furnished with roller bearings. The handle, which is made to fold, embodies a coupling for attachment to a tractor.

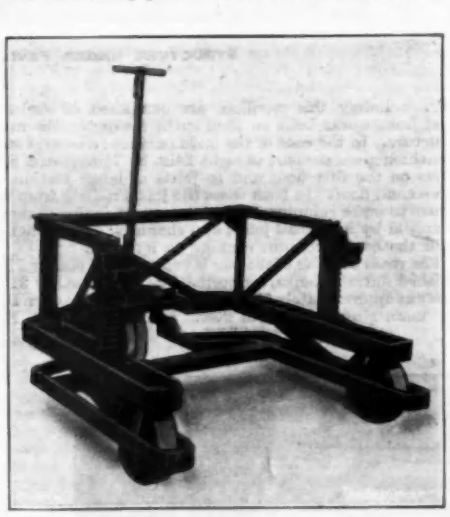


FIG. 2—CABLE DRUM-CARRYING TRUCK

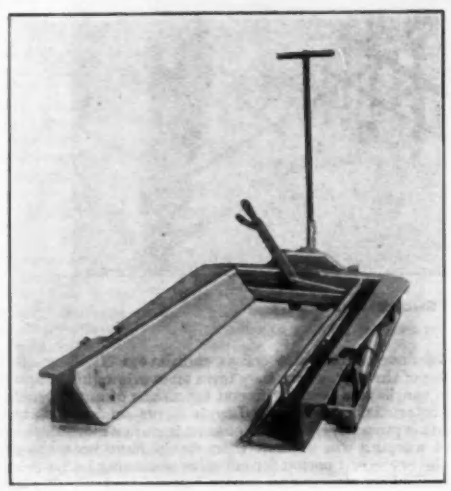


FIG. 3—TRUCK FOR CARRYING ROLLS OF PAPER

These trucks are made in five sizes and will handle cable drums varying in diameter from 3ft. 4in. to 9ft. 2in. and from 43in. to 55in. in width, and weighing from 1 to 5 tons. The height through which the drum is lifted is, in each size of truck, 3in.

Other articles which offer difficulties in handling are the heavy rolls of paper as used for newsprint, packing, &c. The Transporting Machinery and Engineering Company, Ltd., asserts, however, that these difficulties need no longer arise if the truck shown in Fig. 3 be employed. The illustration represents a hand-lift truck specially designed to raise articles of a cylindrical shape directly from the ground and to transport them safely and without injury.

These trucks, which, it is pointed out, are suitable for dealing not only with rolls of paper, but also with beams of cloth and such other things as a variety of circular containers, are somewhat similar in construction and operation to the cable drum lifting trucks. They can be made to suit any special requirements so far as size and diameter of goods are concerned, and they are built of varying capacities, the most generally useful sizes being of from 20 cwt. to 25 cwt. capacity. A single movement of the handle suffices to lift the load.

A further aid to the rapid and easy manipulation of paper rolls and similar articles, which has been introduced by this company, is the automatic releasing grab, which is shown in Fig. 4. This device is specially intended for the handling of such objects in conjunction with overhead cranes, is claimed to have the additional advantage that it preserves the roll of paper from injury.

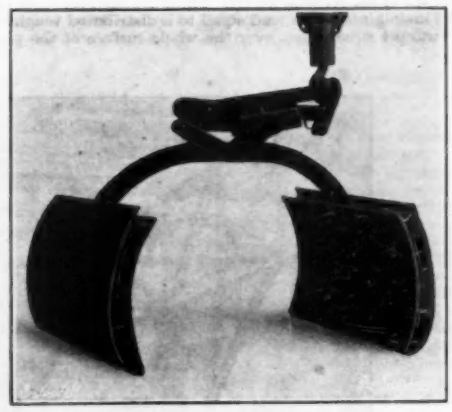


FIG. 4—AUTOMATIC RELEASING GRAB

The grab, which is made of steel, is constructed on the lazy-tongs principle and is furnished with a pawl by means of which the jaws can be held open. In operation, the grab is lowered, open, over the article to be lifted, and the pawl released. When the grab is hoisted up by the crane, the jaws close on the article and raise it. Only 8in. of hoist are, we understand, necessary to close the jaws completely from the fully-open position. Then, when the load is lowered again to the ground, so that its weight is taken off the rope, the pawl drops into engagement and the grab is automatically released so that it can again be hoisted clear. If necessary, too, the automatic release can be operated by a cord when the load is suspended.

DURING 1929, the total quantity of gas made in Great Britain amounted to 6641 million cubic feet—2·2 per cent. over 1928. An increase—4962 million cubic feet, or 2 per cent.—occurred in the quantity of coal gas made, and the quantity of water gas made increased by 1138 million cubic feet, or 2·5 per cent. The coal carbonised was more than in 1928 by 325,000 tons; 30,000 tons less of coke and 1,960,000 gallons more of oil were used in the manufacture of water gas. The quantity of coke and breeze made in 1929 was more than that made in 1928 by 233,000 tons. The quantity of tar made was more by 4,482,000 gallons, but 266 tons less of sulphate of ammonia were produced. The quantity of gas sold increased by 10,168 million cubic feet, or 3·6 per cent. The number of consumers increased by 236,310, or 2·6 per cent.

Reconstruction of the New Brighton Promenade Pier.

THE old New Brighton Pier was condemned as unsafe in 1920 and closed to the public. Several years afterwards, the Wallasey Corporation purchased from the Pier Company the foreshore rights and the structure as it then stood. Meanwhile, decomposition had advanced at so rapid a rate that, after several consultations in committee, the demolition of the old structure, with the exception of a few of the cast iron piles and columns, was advocated. This demolition was begun in 1927 and everything was clear in 1928 for the remodelling and rebuilding which it was decided to carry out.

The cast iron columns which were allowed to remain were the only portions of the original pier which were found to be in a sufficiently safe state of preservation to be embodied in a new structure. That they were so was partly due to the accumulation of barnacles which formed a protective shield against the attrition caused by wave-washed and wind-driven sand. Several of the columns which had been injured by shock in past times and had been strengthened by steel muff-couplings, were further stiffened by adding reinforced concrete so as completely to overlap the couplings, which, under the circumstances, it was considered dangerous to attempt to remove. The reinforcement in each case consisted of six ¾in. diameter vertical rods, fixed by angle rings in halves, bent over at the ends and encased in 3 : 2 : 1 Portland cement concrete, which set "dead-hard" under the water.

Under-bracing.—The columns were all thoroughly braced by steel angles of 4½in. by 3½in. by ⅝in. section, the bracings being entirely re-designed to include a greater vertical dimension than in the old structure, with intermediate points of connection. The old bracings, when removed, were found to be in the last stages of decomposition. Great care, therefore, was exercised to remove only one section of them at one operation, that section being immediately replaced by a new set, so as to preserve what small remaining strength the old bracings possessed, until they were all finally replaced. As the old pier was built in 1861, some idea of the useful life of such structures may be formed.

At the foreshore end of the pier, where a vibration set up by the heavy action of the breakers was distinctly felt, bracings were introduced in positions which were formerly unbraced, with the satisfactory result that no vibratory effects were afterwards evident. At the sea end of the pier, a system of massed bracing was adopted, and, at the north-east end, which has to bear the brunt of the heavy gales experienced on that part of the coast, the bracings radiate in spider formation to a central pillar, the whole arrangement being designed to combat any tendency of the structure to vibrate or allow the columns to "creep" in any direction. Bracings of circular section with the usual turnbuckles were entirely dispensed with, as, owing to all the outer rows of columns canting inwards with a slope of 1 in 12, some sections of the bracing would have been entirely under compressive strain. To reduce the l/r factor of the column strength in a direction parallel to the length of the pier, brackets composed of built-up steel angles were introduced, so as to lessen the effective lengths of the columns by 7ft. These brackets also relieved the main girders of a load equal to a distributed weight of 1 cwt. per square foot over the whole surface of the pier.

UNDER-BRACING, SHORE END

The third function of these bracket-bracings was to act as a longitudinal stiffening.

Main Girders.—All the old girders were carefully tested before the work of reconstruction commenced, with the result that the majority were condemned, the diagonals in some cases being entirely eaten away. In other cases, the remaining steel was less than ¼in. thick. A feature of those girders which were considered sufficiently sound to be retained, was the fact that the bottom flange angles were invariably in far worse condition than the top flanges. These bottom flanges were burned away and renewed *in situ*, a strong steel cable, stretched between the columns, forming a temporary support during the process.

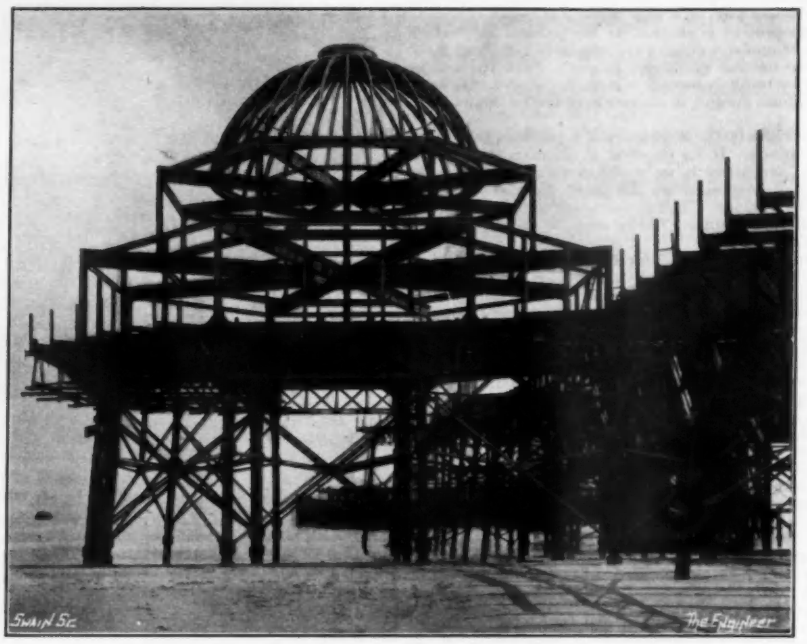
The new girders were designed to allow of an equally distributed load of 1¼ cwt. per square foot over the whole of the pier. That, with the before-mentioned stress of 1 cwt. per square foot taken by the built-up brackets, gave a good margin in excess of the factor of safety adopted. Special girders and supports were employed where dead loads, due to buildings and other structures rendered them necessary—the greatest concentrated load being one of 180 tons under the centre column of the main pavilion.

The main pavilion is octagonal in shape, with two storeys, a verandah and dome, the octagon measuring 66ft. across its parallel sides. All the buildings on the pier, including this pavilion, are composed of skeleton steel frameworks built on steel curbs resting on the main structure. In the case of the main pavilion, a central steel stanchion gives support to eight 24in. by 7½in. plated R.S. joists on the first floor and to joists of lesser section on the second floor. In both cases the joists radiate from the centre to outer columns. The dome, which is zinc-covered, is upheld by bent steel joists and channels, in conjunction with the centre column running to its apex.

The main decking of the pier is composed of 6in. by 2½in. finished Jarrah planks, supported by 9in. by 4in. by 21 lb. joists at approximately 5ft. centres with a span between R.S. the main girder bearers of 20ft. These 9in. by 4in. R.S. joist floor-bearers also act as cantilevers 5ft. long at the sides of the pier, where they form an overhanging gangway, the cantilevers being stiffened by means of angle brackets at intervals. Australian Jarrah forms an ideal material for this purpose, but in the present instance more shrinking and warping was evident than would have been the case if the necessary period for effective seasoning had not been curtailed by strikes and causes beyond control. A rather unusual feature of the decking is that its surface is built convex throughout, similar to a ship's hurricane deck. The planks are fixed to the joists by means of clip-plates and bolts, and a space of ¼in. is allowed in a longitudinal direction between each plank, small wood distance-pieces maintaining that space equally throughout.

The handrail is of strong cast-iron open pattern, which is reinforced for shock-resisting purposes, by 4in. by 3in. by ¼in. steel tee-bars fixed to the ends of the R.S. joist floor-bearers. The top handrail forms a duct for the electric wiring, which is so arranged that the lighting may be made alternate, so that the whole or every other main standard may be illuminated at will.

The whole of the lighting, heating and cooking are controlled from one distribution room in the main pavilion. Alternating current at 2200 volts is supplied to this chamber, where the pressure is transformed down to 200 volts. The heating is on the thermostatic or automatic principle, and requires no supervision except the adjustment of the thermostats to the required working temperatures.



STRUCTURE UNDER PAVILION IN COURSE OF ERECTION

The entire drainage passes through a 4in. diameter cast iron pipe system, with numerous cleaning branches in case of stoppage. This rather small diameter had to be adhered to, as the existing outlet to the main drain, which passes through the thick concrete sea-wall, is only of 4in. bore; but relief tanks were introduced to take peak loads, with entirely satisfactory results.

The pier is 700ft. long with a general width of 75ft. and from 100ft. to 130ft. wide against the main pavilion and across embayments. It was officially opened to the public last Easter.

Contractors may be interested to learn that the whole of the work, including purchase of site, cost £49,000, which contrasts very favourably even with pre-war prices of undertakings of this magnitude. The whole of the contract was sectionalised, fourteen major and thirty-one minor sections being quoted for by individual firms. Most of the work was erected and many parts made by Corporation employees, only unskilled and semi-skilled labour being utilised.

The iron and steel construction and engineering work was entrusted to the care of Mr. E. J. A. Shaw, late Engineer to the Hull Corporation, under the supervision of Mr. L. St. George Wilkinson, M. Inst. C.E., Borough Engineer and Surveyor. Six hundred and sixty tons of cast iron and steel were utilised in the reconstruction. The addition of a large entertainment pavilion is contemplated at some future date, the structure supporting which will be quite independent of, and additional to, existing structure.

CAUVERY-METTUR DAM WORKS.

THE construction of the Cauvery-Mettur Dam, says *Indian Engineering*, generally speaking, progresses satisfactorily. The floods in February disorganised work in the central cofferdam, and delayed excavation for about a fortnight. This delay will be made good before the next flood season, provided there is no repetition of the heavy freshets of the last year. Excavation in the cofferdam should be completed with luck this season as intended. An expenditure of 3,30,12,952 rupees has been incurred from the beginning of the project. The electric spot welder has arrived and is being used for fabricating steel shutters. In connection with the erection of the concreting towers—made by Stothert and Pitt, of Bath, which were described in THE ENGINEER of December 21st, 1928—the tower on the right bank has been finished. The total weight of tower parts erected is about 1530 tons. Three sections of the tower on the left bank are completed. The height reached is 145ft.; 215 tons of tower parts were erected during the quarter, bringing the total to 915 tons. The parts erected include the greater part of the machinery, such as mixers, feed and outlet chutes, winches for aggregate and cement hoists, &c. The erection of the sub-station is practically completed. The transformer and rotary converter have been put in place; and the wiring of the sub-station and erection of control panels are in progress.

The pipes for generating hydro-electric power are arriving. Masonry in the reach where these pipes are to be fixed has been built up to the required level, and preliminaries for the erection and fixing of the pipes in position are in progress, but there has been delay owing

to the needle valves being held up in Madras. One needle valve had, at the time our contemporary's article was written, arrived on the site.

In connection with the excavation of the main dam, 94,728 units were excavated up to the end of the quarter. Out of the total quantity of 480,000 units to complete the dam, 62,293 units were done to the end of the quarter. The output during the quarter averaged 1190 tons per day. The output during the quarter has been satisfactory, but is a little behind programme. The cutting of the Ellis Saddle has progressed very well and is about to be completed, *i.e.*, 10,045 units having been done up to the end of the quarter out of an estimated quantity of 11,000 units. The surplus bridge at Ellis Saddle has progressed well. Masonry is in progress on one abutment, three abutment piers, and nine ordinary piers. Surki was manufactured to the extent of 1750 tons during the quarter. The four bucket elevators ordered arrived in the second week of February. One has been erected and is nearing completion. When all of them have been erected the output will be increased so as to keep pace with the masonry output. The masonry for the right bank crushers is practically finished. Masonry for the bin has been built up to the floor level. Only the superstructure remains to be done.

South African Engineering Notes.

South African Movement to "Buy British."

EVIDENCE of the growing disposition in South Africa to encourage trade between the Union and the United Kingdom is furnished by a movement to "buy British," which has been started. The movement was originated by two Transvaal farmers, Mr. A. C. Trecise and Mr. M. J. R. Boon, and has taken the form of a publicity campaign in favour of British goods. Its objects are summarised in a circular printed in English and in Afrikaans, which is being distributed to the farmers of the Transvaal. The leaflets are headed "Buy Empire Goods." In addition to this campaign by circular, the organisers have raised a fund sufficient to pay for the display of large posters similarly worded to the circulars at 100 railway stations throughout the agricultural districts of the Union. This is only one manifestation of a growing desire among South African producers to give preference whenever possible to British manufactured goods. It is stated that the movement may extend to other organisations throughout the Union.

Black Labour in Industries.

The Minister of Justice, speaking on behalf of the Government of the Union of South Africa, warned industrialists in the course of a speech recently that if they did not provide more work for whites, the Government would be forced to reconsider its whole industrial policy. It appears that as the result of their investigations, Labour Department officials find that many protected industries which were given the advantage of protective tariffs on the understanding that white labour would be employed, are now gradually dispensing with as many of their white workers as possible and replacing them by natives. Industries which proclaimed an "all-white" labour policy at the beginning of their careers have now developed an all-black bias, and young European lads are being replaced by natives. In some cases, a factory is started with a few Europeans brought out from England or the Continent, and they instruct the local white workers in the use of the machinery. Later, as soon as the manufacturer feels he can dispense with the local white workers, they are replaced gradually by natives. As a result, white youths are being forced out of the labour market by vigorous native competition. The Minister's threat has caused great perturbation in industrial circles, and many fear that the protection at present given will be reduced in the case of industries in which black labour is employed.

Nyasaland Railway System.

The approaching construction of the bridge over the Zambesi has afforded the opportunity of bringing about a fusion of the Central Africa Railway and the Shire Highland Railway, for which purpose a new company—the Nyasaland Railways, Ltd.—has been formed. The Central Africa Railway owns 61 miles of railway from Chindio to Port Herald, from which point the line to Blantyre, a distance of 113 miles, is owned by the Shire Highland Railway. It is proposed to continue the railway from Blantyre to Kasanga on Lake Nyasa, a distance of 127 miles. On the other side of the Zambesi, communication with Beira is obtained *vid* the Trans-Zambesia Railway Company, which operates 175 miles of line between Murraca, on the south bank, and Dondo, with running powers thence over the line of the Beira Junction Railway to the Port of Beira. The construction of the Zambesi Bridge, which will have a length of 2½ miles, consisting of 39 spans and an approach viaduct, will necessitate the construction of 28 miles of railway on the southern approach in order to connect the Trans-Zambesia Railway with the bridge.

Fall in Foreign Trade.

Imports into the Union up to the end of June were valued at £32,721,000, compared with £40,925,000 for the same period of last year. This reduction of £8,204,000 represents, for the most part, the reduction in the purchasing power of the Union as a result of the lower prices obtained for the primary products during the latter part of 1929. For the first six months this year there was a decrease in the value of exports of quite 6 millions. Detailed figures are only available for the first quarter of the year as regards either imports or exports. During that period the value of imports from the United Kingdom represented a percentage of 48·8 of the whole, as compared with 44·9 for the corresponding period of 1929. Imports from British possessions represented a percentage of 8·2 as compared with 10·6, while imports from foreign countries were only 43 per cent. of the total, compared with 44·9 in 1929. The reduction in foreign imports is chiefly due to the decrease in imports of motor cars, motor lorries, petrol, &c., from the U.S.A. As regards imports, it is disquieting to find the U.S.A. obtaining so large a share of the mining machinery orders, for out of a total of £856,854, Great Britain supplied £470,675 and the U.S.A. £342,891, while of factory plant the U.S.A. supplied £124,179, Germany £100,677 and the United Kingdom only £45,853. Out of the total of £568,497 for ploughs, harrows and parts, £242,181 came from the U.S.A., £157,178 from Canada, £73,742 from the United Kingdom, and £57,132 from Germany. The considerable drop in the prices of agricultural products is producing a serious state of affairs in the country and unemployment is increasing at a startling rate. Thousands of skilled railwaymen have been placed on short time and many private factories are closed down or working with decreased numbers of employees and often short time as well.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Conditions Unchanged.

THERE has been no development of momentum in industry in the Midlands and Staffordshire during the past week. Most of the heavy engineering industries are experiencing only a lean time, and conditions in the best of instances are but moderate. Demand for iron and steel is unsatisfactory, though here and there better bookings are reported. Producers and consumers alike fail to discern evidences of the autumn trade, and there is a growing tendency to put off anticipation until October. Many who had expected a trade movement this month are now less optimistic, inquiries previously received not having led to concrete business. The recent spell of hot weather, had trade been different, would probably have seriously affected business at the works here, for at many of the Black Country forges work had to be suspended, the puddlers being overcome. Men employed in the chain, anchor, iron and steel works in the South Staffordshire and North Worcestershire districts ceased work as did operatives in the Walsall tube works. Stampers were likewise affected, and work was only possible during the cooler hours. Conditions in the industries concerned, however, are such that these temporary suspensions caused no inconvenience. There was a fairly good attendance on 'Change in Birmingham to-day—Thursday—at the weekly meeting of the iron trade, but transactions were, generally speaking, as modest as of late.

Pig Iron.

Last week I recorded that Midland blast-furnacemen were becoming anxious regarding stocks, and this week I have unfortunately to announce that a beginning is to be made with curtailment of production. One of two furnaces which have been in operation in Northamptonshire for nearly twelve months is to be withdrawn from service. It is much to be hoped that the autumn demand will soon make itself felt, as, failing it, I understand, there is a possibility of further action of this description. On 'Change in Birmingham this week there have been reports of improved buying on the part of some of the foundries, but tonnages continue on the small side. Cases of bulk buying continue rare. Derbyshire blast-furnaces are in many cases allied to foundries which absorb a large portion of their production, and in these cases stocks are not unduly large. Trade prospects at the moment are not hopeful, and a considerable revival of buying will be necessary before the balance of supply and demand is restored. Furnacemen firmly uphold the selling prices fixed by their Association. Derbyshire No. 3 foundry is £3 13s. 6d. per ton and forge £3 8s. 6d., while Northamptonshire foundry sells at £3 10s. and forge £3 5s., all delivered at stations in the Birmingham zone.

Steel.

There is very little movement in the steel market in this district, and producers would be very glad to see a broadening of demand in all departments. The collapse of the continental steel cartel is not likely to improve the position of British steel masters, but, on the other hand, it is considered that it will not more adversely affect the existing run of trade. Native makers, both of finished and semi-finished material adhere to last week's quotations. Prices of continental material on offer in Birmingham this week are also much about the same as they were a week ago. Sheet bars were perhaps to be obtained on slightly better terms. Demand for Staffordshire hoops has fallen off during recent weeks, but the selling price is upheld at £10 per ton at makers' works.

Staffordshire Bar Iron.

Conditions in the Staffordshire finished iron trade show no change from a week ago, except perhaps that there is rather more business being done at one or two of the Crown bar mills. This branch of the industry, as previously reported in this column, is, and has been, very poorly employed, and even a small accession of business immediately makes itself evident. Such demand as there is runs mainly on the larger sizes. Quotations vary from £10 to £10 7s. 6d. A steady trade is maintained in marked bars and the selling price is firm at £12 10s. per ton at makers' works. Producers of wrought iron strip for the tube trade are moderately well employed, and are able to command the full figure of £11 2s. 6d. for their output. Competition in the nut and bolt department is as keen as ever, and Staffordshire makers find it impossible to secure orders against their continental rivals. Belgian No. 3 iron is on offer this week at £5 12s. 6d. Native makers of iron for similar purposes cannot sell at below £9.

Galvanised Sheets.

The galvanised sheet market is slowly gaining ground. Inquiries continue numerous, but the orders which accrue can hardly be termed satisfactory. Increased activity, alike on home and export account, is an essential to regular rolling at the local mills. It is considered by some merchants that a reduction in the selling price would result in increased business, but manufacturers affirm that present trade conditions and circumstances as they see them do not justify any such action as reducing prices. The basis for 24 gauge corrugateds is £11 17s. 6d. f.o.b., with other gauges in proportion. Orders are on the small side. Demand for black sheets is rather better, and the outlook here is considered good. There is no alteration in prices.

Steel Scrap.

Slightly more interest was displayed this week in the steel scrap department of the market. Users in Staffordshire and South Wales were sounding Birmingham merchants as to their lowest selling rates. Very few transactions were put through, the parties being unable to agree as to the market value of this material.

Miners' Wages.

Cannock Chase and Pelsall miners' wages in September, which are based on the ascertainment for May, June, and July, remain at the minimum rate of 42 per cent. on the 1911 basis, although the industry's ability to pay has dropped to 8·94 per cent., compared with 25·2 per cent. in August and 22·95 per cent. in July. A stallman's minimum wage is 9s. 6d. a shift, a loader's 8s. 6d., and an able-bodied surface worker's 6s. 8d.

Edge Tools.

The heavy edge tool industry in this area, after a very slack period, shows a tendency to improve and slightly more activity prevails at the factories. Staffs are very depleted, however, in some cases being mere skeleton of their former selves. Manufacturers this week expressed some optimism as to the near future, some of them anticipating improved business within the next two months. Principals of some of the large firms are still abroad seeking orders.

Unemployment.

Unemployment in the Midlands area is now on the decline, the fall recorded last week being followed by one of 6377, bringing the total to 290,064. The Birmingham figure of 53,086 is less by 222 than it was a week ago, while decreases are also recorded at Coventry, Bilston, Cradley Heath, Leamington and Warwick, Leicester, Northampton, Redditch, Smethwick, Stoke-on-Trent area, Stourbridge and Brierley Hill, Tipton, Walsall, Wednesbury, Wolverhampton, and Worcester. There were, however, increases at West Bromwich, Oldbury, Nottingham, Dudley, and Derby. Of the grand total of 290,064, 113,362 are reported to be on short time or temporarily suspended.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER.

Electricity Extension Plans.

Two important schemes of electrical development in this area are emerging from the discussion stage. In the case of the larger one, application to the Electricity Commissioners for permission to borrow the sum of £178,105 has been authorised by the Stalybridge, Hyde, Mossley and Dukinfield Tramways and Electricity Board. Of this amount, £113,890 is to be allocated to the purchase of cables, £18,945 to motors, £5270 to meters, and £7500 to sub-station equipment. Manchester Corporation Electricity Committee has recommended to the City Council that the sum of £60,000 should be borrowed for the purchase of 33,000-volt mains and new plant for transformer stations in the Denton, Droylsden and Queen's Park areas. In its report to the City Council the Finance Committee states that the annual charges in respect of interest and sinking fund on the loan, amounting to £4646, would be paid out of the electricity revenue account.

Extending Ice-making Plant.

The announcement has been made during the past few days that extensions to the Fleetwood ice-making plant of the Fylde Ice and Cold Storage Company, Ltd., are to be put in hand immediately. The capacity of the existing installation is about 300 tons of ice a day, and it is to be increased to 375 or 450 tons, the size of the new plant not yet having been decided upon. Large stocks were held at the opening of the summer season, but notwithstanding the fact that the works have been operating day and night the supply has been insufficient to meet the increasing demand.

New Type of Armoured Car.

Crossley Motors, Ltd., Gorton, Manchester, have under construction for the Government an armoured car, among the chief features of which are its six-wheeled chassis and its large six-cylinder engine. Two machine guns are to be carried, one being housed in a revolving tower on the roof. A wireless installation is also included. The walls of the car are fitted with sliding panels.

Non-ferrous Metals.

One or two sections of the non-ferrous metals market this week have been a shade more lively, and, on the whole, the undertone has been steadier. Improvement in the demand, however, has not been very noticeable in the case of copper, and dealings both in standard and refined descriptions of the metal have been on a relatively quiet scale, lack of confidence in the statistical position, quite apart from the quiet conditions at the consuming end, having a restrictive influence on buying operations.

Nevertheless, prices in this section are a few shillings higher on balance for the week. The demand for tin is said to have been rather more active but in this case values have had more difficulty in surmounting the handicap of heavy stocks held in this country, further additions having been reported. Tin prices at the moment of writing have not changed very much although, if anything, there has been a slight loss on the week. Lead still occupies a reasonably steady position and as supplies in relation to the demand are not excessive, quotations are being maintained without very great difficulty. Spelter has attracted a moderate amount of attention during the past week, and in the aggregate a fair turnover has been reported. The outlook with regard to prices is not too certain, but, compared with a week ago, somewhat higher values are now being indicated.

Iron and Steel.

Current developments in certain department of the iron and steel trade locally are in the right direction, although, at this stage, sellers are not too sanguine that the slight improvement that has been experienced will prove to be more than a temporary spurt. There has certainly been some expansion in the demand for foundry iron, and whilst the general policy of consumers in this area is to continue the hand-to-mouth buying which has been such a marked feature of operations during the greater part of the past twelve months, conditions at certain at least of the Lancashire foundries are believed to be better than they were. For delivery equal to Manchester, Staffordshire and Derbyshire brands of pig iron are quoted at 72s. per ton, with forge iron at 67s., Scotch No. 3 at about 93s., and West Coast hematite at 87s. per ton. No more than a quiet trade is passing in Lancashire bar iron, with Crown quality material still offered at £10 5s. per ton and seconds at about £8 15s. In the steel section of the market, alloy steels during the past week have been the subject of increased inquiry and also of more actual business, but in the heavy steel trade there has been no apparent improvement in the situation, constructional engineers, boilermakers, textile machinists, locomotive builders, and pretty well all other branches taking only relatively small quantities. Prices in almost every respect, however, are maintained at late rates, although there is a growing belief among users in this area that reductions as the outcome of the meeting of the Steel Association next month are not improbable. The collapse of the marketing schemes in connection with continental materials has been reflected in a further definite weakening of values, billets and sheet bars being obtainable at about £4 15s. per ton, including delivery locally, angles at £5 7s. 6d., joists at £5 10s., steel bars at £5 7s. 6d., Siemens plates at £7, Thomas plates at down to £6 5s., and bar iron at £5 7s. 6d. Sales are still slow, but a definite expansion in the demand for imported products is expected before long.

BARROW-IN-FURNESS.

Hematites.

Business in West Coast hematite pig iron is exceedingly quiet and more iron is being produced than can be found a sale for, so that the stocks of iron in makers' hands are increasing. There are, in all, ten furnaces in blast, and it is quite likely that a cut will be made somewhere in the district, for there are no immediate signs of any improvement. The local consumption is easy. Workington has a fair demand, but there is no outlet at present to Barrow steel makers. Trading is from hand-to-mouth, only immediate wants being covered. There is a fair demand for malleable iron.

Iron Ore.

The demand for hematite iron ore is largely local, the Scottish and East Coast consumption being quiet. There is not much Spanish ore coming into Barrow just now.

Steel.

The position in the steel trade is not so good. There is some activity at Workington, rolling rails, mostly, but the Barrow plant is still standing idle, with no immediate prospect of a re-start. The only activity is the branch hoop and bar mills. Hoops are in steady demand. Rails are in very quiet demand, both on home and overseas account.

Shipbuilding and Engineering.

There is a fair amount of activity in the shipbuilding and engineering trades as regards mercantile work, but there is quietness with regard to warship construction. The demand for new shipbuilding tonnage is moderate.

Fuel.

There is a fair call for fuel, both coal and coke, the majority showing no alteration.

Shipping.

The shipping trade is quietly employed A part cargo of pig iron was recently sent from Barrow Dock to Hong Kong, otherwise the iron shipments were only coastwise. A fair amount of oil is being imported into Barrow.

SHEFFIELD.

(From our own Correspondent.)

Indications of Improvement ?

SHEFFIELD people are asking themselves the question, "Is there any sign of the steel trade improving on its present doleful position and of that revival of buying which is usually experienced in September ?" It is thought that there are slight evidences of a tendency on the part of trade to raise its head a little higher. These evidences come principally from the tone of the scrap market. This is somewhat firmer than it has been, and dealers are declining to reduce their prices any further. They report that, while deliveries are no better, inquiries are growing more numerous, thus encouraging hopes of larger purchases in the near future. In the meantime, actual conditions at the works are as bad as ever. The open-hearth furnaces in commission number little more than a quarter of those with which the district is equipped, and there is an absence of bulk ordering. The business which is being booked for billets, strips, and rods is, for the most part, of little weight or value, and it is impossible to foresee the continued working of the plants, even at their present low level, for more than a week or two in advance. The number of unemployed in the Attercliffe district is nearly twice as large as it was a year ago, the increase being largely due to dismissals following reorganisation.

General Depression.

The depressed state of industry in Sheffield has become more general than has been the case in previous periods. There are a number of firms, more fortunate than the rest, who have been able to maintain a fair level of activity during other slack times, but now most of these are affected, and the favourable exceptions are few and far between. There is still a large call for stainless and rustless steels, which are constantly being applied to new uses in the oil, chemical, and allied industries, but the demand is not as healthy and progressive as formerly. A smilar state of things characterises the trades in automobile supplies, and in cold-rolled steel and strip. In the lighter branches generally, however, it is thought that the downward movement has run its course, and that signs of better things are showing themselves. There is some revival of confidence in trade as far as the home market is concerned, but the fall in overseas business is a very serious matter, and prospects in that direction show no brightening.

The Tool Trades.

There is a fairly steady demand for edge and joiners' tools, twist drills, cutters, and hacksaws, from most markets, but trade with Australia shows a falling off. The quietude in the same market has also affected makers of sheep shears, who are badly off for work. Their principal outlet for their goods is Australia, but orders from that quarter this season has been on a much smaller scale than usual. Canada and South America have taken moderate shipments, but there has been a fair trade in this country. Trade in plantation tools continues on a very unsatisfactory basis; not only is German competition severe, but the requirements of the plantation owners appear much smaller than they formerly were. The seasonal trade in farm and garden tools has been below that of last year, and makers are not at all well employed. The establishment of ice rinks in this country is expected to create an increased demand for skates, and local firms are exerting themselves to meet it. "*Quality*," the journal of the Sheffield Chamber of Commerce, reports that at least one firm has extended its productive facilities, and is offering a new pattern of skate specially suitable for rinks at a popular price. The value of tools exported in July was £229,058, which was a slight improvement on the June figure, but £125,000 less than that of July last year. During the first seven months of this year there was a decline of £420,000. The reduction applies to all kinds of tools. Imports for July, at £67,424, showed a reduction of £8000 as compared with June, and of £20,000 as against July last year, the total decline for the seven months being £70,000. There are now several firms in Sheffield making safety razor blades to retail at 1d. each, in competition with those which come from Germany, and a good sale for these articles is reported.

Corporation Contracts and Loans.

A number of interesting items as to contracts and forthcoming work appear on the minutes of Sheffield City Council this month. The Tramways Committee has given a contract to John Brown and Co., Ltd., for 500 steel tramcar tires, at £3 4s. each; and has also accepted tenders from Leyland Motors, Ltd., for the supply of ten motor omnibuses complete—five double-deckers and five single-deckers. The Electric Supply Committee has accepted the tender of Ferranti, Ltd., for the supply and delivery of six transformers, at the price of £627. The Electricity Commissioners have sanctioned the borrowing of £175,000 for services, and £75,000 for sub-station equipment. The Ministry of Health has sanctioned the borrowing of £52,800 for street and sewer works on the Shiregreen estate.

A New Company.

It is announced that a new company, to be called the Universal Rustless Steel Corporation, is to be formed for the manufacture of stainless steel commodities. The prime mover in the venture is Mr. P. R. Kuehnrich, who is well known in connection with the mass production of safety razor blades by Darwins, Ltd., but is understood that the new firm will not manufacture anything at present made by Darwins. There are to be two works, one at the Derbyshire village of Calver, where a large mill, originally a cotton mill, is to be used, and the other at Attercliffe, Sheffield.

Lincolnshire and the Humber Bridge.

Since I last wrote, there has been an interesting development in connection with the project for bridging the Humber, near Hull, at a total cost of about 1¼ million sterling. The Lindsey County Council, which is largely interested in the Lincolnshire side of the scheme, and which was reported to be hesitating about its contribution, has decided to subscribe £30,000, subject, however, to five important conditions. It is pointed out that when the Hull Corporation has made its contribution, it will be faced with no further cost in connection with the scheme, but the Lindsey County Council will be compelled, in order to meet the demands of the traffic, to undertake very extensive road works, as the construction of the bridge will make Lindsey into a "corridor" for the county. It is estimated that the cost of providing roads to by-pass Barton-on-Humber, and to connect the bridge with the existing scheme in Lindsey, will be £85,000. According to a statement by the Clerk of the County Council, the Ministry's view is understood to be that this expenditure should be undertaken by the Council, with the aid of a 75 per cent. grant, and should not form part of the scheme for the construction of the bridge. One of the Council's conditions, however, is that these roads shall be included in and financed as part of the scheme. Another condition is that a satisfactory undertaking is obtained from the Ministry that grants of not less than 85 per cent. will be available in respect of certain Lindsey roads, which will be rendered necessary by the construction of the bridge. It is estimated that the cost of these additional road works, during the twenty years following the construction of the bridge, will be £300,000, exclusive of the £85,000 already mentioned.

NORTH OF ENGLAND.

(From our own Correspondent.)

Cleveland Iron Trade.

The Cleveland pig iron trade shows little change on the week. The needs of ironmasters' own consuming departments are likely to continue to use, in its molten state, the bulk of the output, and producers reporting inquiries encourage the belief that home consumers, who have to come on to the market for supplies, will readily accept the surplus output that is run into the pig beds. There is little prospect of much expansion of export demand. Second hands' opportunities of putting through much business continue few, owing to conditions of contracts with ironmasters prohibiting extensive merchants' sales to principal home consumers and continued obstacles to transactions with overseas firms. Makers' fixed minimum prices are unchanged, No. 1 Cleveland foundry iron being 66s.; No. 3 G.M.B., 63s. 6d.; No. 4 foundry, 62s. 6d., and No. 4 forge, 62s.

Hematite Pig Iron.

The East Coast hematite branch is steady, and the opinion is growing that slight alteration for the better is about to be experienced. Producers have heavy stocks at their yards, large proportions of which are, however, sold, and as consumers hope to shortly accept arrears of delivery more freely than of late, the unsatisfactory statistical position may quickly show a change for the better. Meanwhile, makers adhere to their quotations on the basis of ordinary qualities at 71s., though they have to contend with continued continental competition and underselling by merchants, both for home and export trade. Second-hands have still command of considerable quantities. No. 1 quality is 71s. 6d.

Ironmaking Materials.

Consumers of foreign ore have very large stocks in hand, and new business is rarely heard of. The price of best Rubio ore is nominal at 19s. c.i.f. Tees. Blast-furnace coke is plentiful. Prompt parcels of good average qualities are obtainable at 16s. 6d. delivered to works in this area, but sellers ask up to 17s. 6d. for forward supplies.

Manufactured Iron and Steel.

Little new is reported in the manufactured iron and steel trade. While prospect of early material improvement in trade is by no means bright, the outlook generally is less discouraging. Several firms have still a good deal of work to execute, and a few new orders have been secured. Hope is expressed that tonnage output will be maintained in departments producing railway material, constructional steel and sheets. Prices are unchanged.

Exports and Imports.

Diminished exports of iron and steel from the River Tees during August reflect the depressed state of the industry. Pig iron shipments totalled 16,863 tons, as compared with 16,920 tons in July, and those of manufactured iron and steel reached only 46,176 tons as against 54,549 tons. Steel shipments to Australia have almost ceased, and India, once Cleveland's best customer, is in a state of political ferment, which is seriously restricting the free flow of commodities. South Africa, however, is taking large quantities of railway material from this district, and nearly 10,000 tons were sent there last month. During the past ten months 123,079 tons of iron and steel have been imported into the district from foreign sources, as compared with 155,832 tons in the corresponding period of 1928–29, and 53,399 tons in the same ten months of 1913–14. In August, 10,367 tons were imported, as compared with 13,269 tons in July.

The Coal Trade.

There is no new feature in either the Northumberland or Durham coal trade. Coal continues to offer abundantly, and, poor as the August trade was, there appear at the moment few signs of improvement for the current month. There is apparently certain to be a lot of idle time, and, until the various agreements are reached under the Coal Mines Bill, and merchants have an opportunity of working out how export trade will be affected, little improvement is expected. Colliery fitters take a rather gloomy view of the general outlook, and do not anticipate anything in the nature of a spirited demand before the early winter. Northumberland steam coals are, perhaps, just a turn steadier. First quality large is quoted at 13s. 6d. and seconds at 12s. Steam smalls are in moderate supply, but under a neglected demand prices are easy and unaltered at 10s. to 10s. 6d. Practically all classes of Durham coal offer in excess of requirements, although the production of every grade is below that of July. Gas coal sellers sold for recent prices, but there is no strength in the undertone. Best qualities are quoted at 15s. Secondary gas is easier in tone at 12s. 6d. to 13s. Best class bunker coals are moving steadily at rather firm prices, but other qualities show weakness. The coke trade is dull. Patent oven coke stocks are considerable

and pressed on the market for prompt clearance at discount prices, but all September shipment and more forward positions the undertone is steady, and 17s. 6d. to 18s. is quoted. Beehive and superior foundry coke production is restricted to definite orders, and prices hold firmly at 24s. to 28s. Gas coke is scarce and quoted unchanged at 21s. 6d.

Coal Trade Proceeds and Costs.

Outstanding facts in the ascertainment of the Northumberland coal trade for July, which regulates wages this month, are an increase in the output as compared with the previous month, a decrease in the loss per ton, a decrease in the number of men employed, but an increase in the number of shifts worked. The percentage payable on the basis wages for September would have been 10·53, but for the minimum percentage clause in the wages agreement fixing the figure at 40. The percentage for the previous month worked out at 10·52. This means that the owners will have to sacrifice £60,550 of their share of the proceeds to maintain wages at the minimum, making a total deficiency of £2,580,168. The trading loss on the industry during July was £15,222, which averages 3·94d. per ton. In June the trading loss was £14,548, or 4·05d. per ton. The output increased from 862,583 tons in June to 926,483 tons in July, and the total proceeds from £491,641 to £524,257.

SCOTLAND.

(From our own Correspondent.)

Shipbuilding.

THE output from the Clyde shipyards during August was almost double that of July, and considerably in advance of the average August production. Unfortunately, however, it must again be pointed out that although outputs are maintained, the outlook in the industry has not shown any improvement so far as the placing of new tonnage is concerned. Few yards are busy, and several have only one ship on the stocks. The August output amounted to nineteen ships of 59,531 tons aggregate, which brings the output for this year to date up to 144 ships of 384,549 tons aggregate, compared with 150 ships of 373,133 tons aggregate in the same period last year. Of the ships launched during last month, eight were of 5000 tons or over, the largest of which was the "Kenya," twin-screw passenger ship, of 9700 tons, built for the British India Steam Navigation Company, Ltd. The only order of any note reported during August was one for a passenger and fruit-carrying ship of 6000 tons gross, for the Jamaica Direct Fruit Line, Ltd.

Steel.

The position in the steel trade does not yet show any movement towards improvement. The general demand is most unsatisfactory and great difficulty is experienced in maintaining employment, few makers being able to see more than a few days ahead. Boiler plates, ship plates, and sections are poorly specified at present, and lighter materials are more or less neglected. Tube makers have fair orders for heavy pipes. Small tubes, however, especially butt welded descriptions, are not doing much in the way of fresh business. The dulness is attributed to a drop in overseas demands, the Australian market being practically dead at present, and inquiries from the East and South America being on most restricted lines, particularly when compared with the usual turnover in small tubes. Business in sheets is only moderate. Black sheets are fairly well specified, but galvanised descriptions are very quiet. Prices are unchanged.

Iron.

In the Scottish pig iron industry only eight furnaces are in blast, and in view of the cheap prices quoted for Indian and continental pig iron, home makers are not likely to increase their production meantime. Only a portion of the bar iron plant is in operation, and the re-rolled steel bars department also is inactive. The latter department is considerably affected by the weakness of the continental position. Light steel bars have been on offer at £4 5s. per ton f.o.b. Antwerp, while the local quotation for re-rolled steel bars is still £7 12s. 6d. per ton, home or export.

Coal.

The lack of export demands is still the outstanding feature in the Scottish coal market. Lanarkshire splints are comparatively well sold and ells have improved, owing to increased Irish demands, but practically all other descriptions of round coals are more or less inactive. Collieries anticipated that an expansion in home demands would help to improve matters, but so far there has not been any indication of an increase in land sales. During the past week shipments amounted to 223,804 tons, against 230,626 tons in the preceding week and 287,429 tons in the same week last year.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

The Coal Trade.

ALTHOUGH there can be no doubt that conditions in the steam coal trade, as judged by day to day operations, appear to be very dull, still there is reason to confirm the view expressed a week ago that the situation on the whole is slightly better and more promising. Shipments last week were a shade better, as was expected in view of the fact that the number of idle tipping appliances was on a lower level. As a matter of fact, according to the Great Western Railway Company's returns, the total for the six leading ports came to 540,300 tons, which compared with 522,800 tons for the preceding week, though the total was well below the quantity for the corresponding period of last year, when the figure was 601,610 tons. The number of idle appliances at the various docks on Saturday was thirty, and there were seven steamers waiting to berth. The position on Monday, as the result of week-end arrivals, was that there were only thirteen tips idle and six vessels were waiting. It will thus be seen that collieries made a better start this week, and there can be no question that many undertakings are getting along better, and are losing less time. Irregularity, of course, exists, as between individual collieries, but this irregularity is not so pronounced and there are indications of steadier working conditions as chartering operations have been more active, while the demand for tonnage is more pressing. As mentioned a week ago, merchants are finding it more difficult to secure the tonnage they require, and it is not surprising to see that the tone of the outward freight market for West Italian ports has distinctly improved. There is a better feeling all round in the freight market, which is a healthy sign. Rates have been on an unhealthy level long enough, and an advance is inevitable. Rumours have been going the round that French State Railways were the buyers of a million tons of coal from South Wales, and that the Italian Government were taking double the quantity next year that they have been taking this year. There is nothing to justify the report so far as it concerns the Italian business, and as regards the French Railways, there is no reason to assume that they will not take their usual quantity of coals from this district. It may easily run to the figure of a million tons, and there is nothing special in that, as these undertakings are frequently in the market buying different quantities. Firms were asked recently to quote for a quarter of a million tons, but so far as can be gathered, they have not received a reply to their offers.

Steel Works and Other Developments.

As mentioned last week, the Dowlais Iron and Steel Works at Merthyr re-opened on Monday, and this is regarded as a good omen, but its significance must not be magnified too much. It is, of course, welcome, as it means re-employment for about 1500 men, and, following in its wake, is the announcement that pits in the vicinity are also re-starting. Various rumours are current in this district of a somewhat more interesting character, as these have reference to important developments in connection with the iron and steel works of the British (Guest, Keen, Baldwins) Iron and Steel Company, Ltd., at Cardiff. The re-modelling and reconstruction of their works at Cardiff, which would entail the outlay of a tremendous amount of money, would be a scheme of very far-reaching effect. It would place this undertaking in a much stronger position to compete for orders available, as their costs of production would be substantially reduced. No confirmation of such developments are so far obtainable, but they are not unlikely. Reference has been made in the past to the increasing demand for sized coals and the fact that only lack of resources has prevented many colliery undertakings from putting down up-to-date plant to meet market requirements. News now comes that the Newport Abercarn Black Vein Steam Coal Company, Ltd., which is a subsidiary of the Ebbw Vale Steel, Iron and Coal Company, Ltd., has given an order to Nortons (Tividale), Ltd., of Tipton, for a large modern washery of the latest automatic type, designed to deal with 250 tons per hour in two units of 125 tons each. The construction of the washery is to be commenced immediately, and it will be one of the largest in South Wales.

Marketing Scheme and Coal Audit.

Colliery owners for South Wales met at Cardiff on Monday when the principles to be embodied in the marketing scheme for this district, which has to be submitted to the Board of Trade, were explained and approved. The scheme, which has been in operation, has only had the support of 80 to 85 per cent. of the coalowners, but under the Coal Mines Act it becomes compulsory upon all owners. As a consequence, there was also on Monday a meeting of the minority owners when they nominated six representatives to act with the Executive Committee of the Marketing Association in completing the scheme for submission to the Board of Trade. Details have also been issued of the report of the joint accountants for the South Wales coalfield for the three months ended July 31st. This is much less favourable than for the preceding three months. It shows a decrease in the average realised pithead price per ton, an increase in the wages cost alone of 4½d. per ton and a slight increase also in costs of production other than wages. This rise in the cost of production was due principally to a decline in output and the net effect of these changes was a trading profit for the three months of only £28,311, equivalent to 0·67d. per ton on the total quantity of coal raised, compared with £314,324, or 6·71d. per ton in the previous three months. But for the rebate on railway rates allowed under the Derating Act of 1929, this small profit of £28,311 would have been converted into a substantial loss The percentage on the 1915 basis wages certified is 8·66 per cent. compared with 15·05 per cent. under the preceding audit, and the difference between this certified percentage and that of the minimum of 28 per cent. on the 1915 basis rates provided for by the present wages agreement has to be made up by the colliery owners.

Dry Docks at Cardiff Acquired.

The three dry docks and engineering shops situated at the East and West Bute Docks, Cardiff, which belonged to the Hills' Dry Docks and Engineering Company, Ltd., now in liquidation, have been acquired, after several weeks of negotiations, from the liquidator by the old-established firm at Cardiff of T. Diamond and Co., Ltd. It is very satisfactory to find that the dry docks and plant are not to be scrapped, as at one time was to be feared. The purchase price has not been disclosed.

Record Coal Raising.

A record in coal raising has been established at the Penalta Colliery, belonging to the Powell Duffryn Company at Ystradmynach, near Bargoed. Last Friday the quantity of 5532 tons was raised, which compares with the previous record created early this year of 4665 tons. The new record represents one day's coal, which was raised in two winding shifts.

Current Business.

There is no perceptable alteration in the general state of the steam coal market, though there is a steadier feeling prevalent. This has not manifested itself in any improvement in prices. Sized coals continue to be relatively the steadiest section. Coke and patent fuel are quiet, while pitwood meets with a fair request at about 27s.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

CIRRUS AERO-ENGINES, Ltd., asks us to announce that in future correspondence should be addressed to it at the Aircraft Depôt, Purley-way, Waddon, Croydon, Surrey.

J. W. BROOKE AND CO., Ltd., ask us to announce that they have found it necessary to re-organise their engine factory to enable them to cope with the steadily increasing demand, and that they have recently been successful in obtaining the services of Mr. W. A. Davenport.

OZONAIR, Ltd., asks us to announce that the lease of its offices at 90, Victoria-street, London, S.W. 1, having expired, it has arranged to remove to an office building and works which have been specially designed and erected for its accommodation at St. Leonard-street, London, S.W. 1, to which it is requested that all future correspondence should be addressed. Telephone No., Victoria 0012; telegrams, Ozonair, Sowest, London.

LAUNCHES AND TRIAL TRIPS.

PETER HURLL, motor ship; built by Palmer's Shipbuilding and Iron Company, Ltd., to the order of the Standard Shipping Company; dimensions, 520ft. by 70ft. by 28ft. 9in. draught; deadweight, over 16,000 tons. Engines, Krupp type; constructed by the builders; launch, July 24th.

HARPERLEY, steamship; built by William Gray and Co., Ltd., to the order of the National Steamship Company, Ltd., dimensions, 413ft. 6in. by 54ft. 6in. by 27ft. 3¼in. Engines, triple-expansion, 25in., 41in. and 68in. diameter by 45in. stroke, pressure 180 lb. per square inch; constructed by the builders; trial trip, July 25th.

PEIK, motor tank ship; built by Sir W. G. Armstrong, Whitworth and Co. (Shipbuilders), Ltd., to the order of Jans J. Salvesen's Rederei A/S.; dimensions, 408ft. by 54ft. 9in. by 32ft.; to carry 8970 tons. Engines, Armstrong-Sulzer two-stroke, single-acting Diesel; constructed by Sir W. G. Armstrong, Whitworth and Co. (Engineers), Ltd.; launch, July 25th.

NORE, motor ship; built by Swan, Hunter and Wigham Richardson, Ltd., to the order of Johan Rasmussen and Co.; dimensions, 474ft. by 59¼ft.; to carry 11,300 tons of oil in bulk. Engines, Wallsend-Sulzer Diesel; constructed by the builders; launch, July 28th.

CATALOGUES.

SIEMENS BROTHERS AND CO., Ltd., Woolwich, S.E. 18.—Pamphlet 155a on "Super-tension Cables."

HOWDEN-LJUNGSTROM PREHEATERS (LAND), Ltd., Caxton House, S.W. 1.—Full details of the firm's air preheater.

CHARLES E. DOUGLAS AND CO., Ltd., Cecil Chambers, 76, Strand, W.C. 2.—Particulars of the "Superwash" mechanical filter.

COCHRAN AND CO. (ANNAN), Ltd., Annan.—Particulars of boilers as applied to the utilisation of exhaust heat from Diesel engines.

A. REYROLLE AND CO., Ltd., Hebburn-on-Tyne.—A pamphlet of Messrs. J. H. Holmes, describing the "Castle" electric welding equipment.

TECALEMIT, Ltd., Mitre House, Scrubb's-lane, N.W. 10.—An illustrated catalogue of the "Tecalemit" lubrication systems and accessories.

CAMBRIDGE INSTRUMENT COMPANY, Ltd., 45, Grosvenor-place, S.W. 1.—List and Supplement 162, dealing with alternating current instruments and their technical applications.

BRITISH DARDELET THREADLOCK (D.D.G.) CORPORATION, Ltd., 42, Kingsway, W.C. 2.—Particulars and principles of the Dardelet bolts and nuts, which are of the self-locking type.

WELLMAN SMITH OWEN ENGINEERING CORPORATION, Ltd., Victoria Station House, S.W. 1.—A brochure dealing with the Terni furnace, a recent development in open-hearth practice.

HARLAND ENGINEERING COMPANY, Ltd., Alloa.—Publication X 50/3006, illustrating some typical productions, including centrifugal pumps, direct-current and alternating-current electrical machinery, high-tension and low-tension switchgear, &c.

CITY OF LONDON COLLEGE: LECTURES ON "IRON AND STEEL."—A course of twenty-five lectures on "Iron and Steel" will be given by Mr. T. Barton Kelly at the City of London College, Ropemaker-street, Moorfields, E.C. 2. The lectures will be delivered on Tuesdays, from 6.30 to 7.30, and will begin on September 23rd next. A college examination in iron and steel will be held at the conclusion of the course, and Short Course Certificates awarded to successful students. "The J. Gray Buchanan Prize" of £3 will be given on the results of the examination. Further particulars can be obtained on application to the secretary of the College.

BORDEAUX LANDING STAGE.—A new landing stage, constructed by the M.A.N., has recently been brought into use at Bordeaux. The gangway, which is about 46ft. long, is fixed at the shoreward end to a portal carriage about 16ft. high to bring it to the level of the railway platform. This carriage runs along a rail track some 160ft. long, alongside the quay, and can therefore be moved readily to any desired point. The gangway at the forward end rests on the ship's deck and is raised or lowered according to the height of the deck. Its weight is practically balanced by counterweights so that the motor power required is only 10 H.P. According to requirements, the gangway may be swung sideways to the extent of about 5ft., and moved backwards about 11ft. Each motion is operated individually by electric driving gear. The gangway is about 5ft. wide and protected at the top and sides by awnings against the weather. A short connecting gangway joining up at the end on the quay forms a communication to the railway platform.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. COAST—	
(1) Native	17/9 to 20/6
(1) Spanish	20/6 to 21/–
N.E. COAST—	
Native	18/– to 21/–
Foreign (c.i.f.)	19/–

PIG IRON.

	Home. £ s. d.	Export £ s. d.
(2) SCOTLAND—		
Hematite	3 18 6	—
No. 1 Foundry	3 19 0	—
No. 3 Foundry	3 16 6	—
N.E. COAST—		
Hematite Mixed Nos.	3 11 0	3 11 0
No. 1	3 11 6	3 11 6
Cleveland—		
No. 1	3 6 0	3 6 0
Siliceous Iron	3 6 0	3 6 0
No. 3 G.M.B.	3 3 6	3 3 6
No. 4 Foundry	3 2 6	3 2 6
No. 4 Forge	3 2 0	3 2 0
Mottled	3 1 6	3 1 6
White	3 1 6	3 1 6
MIDLANDS—		
(c) Staffs.—	(*Delivered to Station.*)	
All-mine (Cold Blast)	—	—
North Staffs. Forge	3 8 6	—
„ „ Foundry	3 13 6	—
(c) Northampton—		
Foundry No. 3	3 10 0	—
Forge	3 5 0	—
Derbyshire—		
No. 3 Foundry	3 13 6	—
Forge	3 8 6	—
(3) Lincolnshire—		
No. 3 Foundry	—	—
No. 4 Forge	—	—
Basic	—	—
(4) N.W. COAST—		
N. Lancs. and Cum.—		
Hematite Mixed Nos.	4 3 6 (*a*)	—
	4 6 6 (*b*)	—
	4 10 6 (*c*)	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
SCOTLAND—		
Crown Bars	10 5 0	9 15 0
Best	—	—
N.E. COAST—		
Iron Rivets	11 10 0	—
Common Bars	10 15 0	—
Best Bars	11 5 0	—
Double Best Bars	11 15 0	—
Treble Best Bars	12 5 0	—
LANCS.—		
Crown Bars	10 5 0	—
Second Quality Bars	8 15 0	—
Hoops	13 0 0	—
S. YORKS.—		
Crown Bars	10 5 0	—
Best Bars	11 0 0	—
Hoops	12 0 0	—
MIDLANDS—		
Crown Bars	10 0 0 to 10 7 6	—
Marked Bars (Staffs.)	12 10 0	—
Nut and Bolt Bars	9 0 0 to 9 5 0	—
Gas Tube Strip	11 2 6	—

STEEL. (*d*)

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) SCOTLAND—		
Boiler Plates (Marine	10 10 0	10 10 0
„ „ (Land)	10 0 0	10 0 0
Ship Plates, ½in. and up	8 15 0	7 15 0
Sections	8 7 6	7 7 6
Steel Sheets, ¼in.	9 0 0	8 15 0
Sheets (Gal. Cor. 24 B.G.)	12 15 0	12 5 0

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. COAST—		
Ship Plates	8 15 0	7 15 0
Angles	8 7 6	7 7 6
Boiler Plates (Marine	10 10 0	—
„ „ (Land)	10 0 0	—
Joists	8 10 0	7 7 6
Heavy Rails	8 10 0	—
Fish-plates	12 0 0	—
Channels	10 5 0	£9 to £9 5s.
Hard Billets	8 2 6	—
Soft Billets	6 17 6	—
N.W. COAST—		
BARROW—		
Heavy Rails	8 10 0	—
Light Rails	8 15 0 to 9 0 0	—
Billets	6 15 0 to 9 10 0	—
MANCHESTER—		
Bars (Round)	9 7 6	—
„ (Small Round)	7 17 6 to 8 0 0	—
Hoops (Baling)	10 0 0	9 15 0
„ (Soft Steel)	9 0 0	8 15 0
Plates	8 17 6 to 9 2 6	—
„ (Lancs. Boiler)	9 15 0	—
SHEFFIELD—		
Siemens Acid Billets	9 10 0 (basis)	—
Hard Basic	9 2 6 and 9 12 6	—
Intermediate Basic	7 12 6 and 8 2 6	—
Soft Basic	6 10 0	—
Hoops	9 15 0	—
Soft Wire Rods	8 0 0	—
MIDLANDS—		
Small Rolled Bars	7 17 6 to 8 10 0	—
Billets and Sheet Bars	5 17 6 to 6 5 0	—
Galv. Sheets, f.o.b. L'pool	11 17 6	—
(2) Staffordshire Hoops	10 0 0	—
Angles	8 7 6	—
Joists	8 10 0	—
Tees	9 7 6	—
Bridge and Tank Plates	8 17 6	—
Boiler Plates	9 12 6	—

NON-FERROUS METALS.

SWANSEA—	
Tin-plates, I.C., 20 by 14	18/– to 18/1¼
Block Tin (cash)	133 12 6
„ (three months)	135 7 6
Copper (cash)	46 16 3
„ (three months)	46 18 9
Spanish Lead (cash)	18 5 0
„ „ (three months)	18 2 6
Spelter (cash)	16 2 6
„ (three months)	16 11 3
MANCHESTER—	
Copper, Best Selected Ingots	51 10 0
„ Electrolytic	52 0 0
„ Strong Sheets	79 0 0
„ Tubes (Basis Price), lb.	0 0 11¾
Brass Tubes (Basis Price), lb.	0 0 10¾
„ Condenser, lb.	0 1 0¾
Lead, English	19 12 6
„ Foreign	18 5 0
Spelter	16 10 0
Aluminium (per ton—raw ingot)	£95

FERRO ALLOYS.

	Per Ton.	Per Unit.
Tungsten Metal Powder	2/6 per lb.	
Ferro Tungsten	2/3 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£23 12 6	7/–
„ „ 6 p.c. to 8 p.c.	£22 10 0	7/–
„ „ 8 p.c. to 10 p.c.	£22 0 0	7/–
„ „ Specially Refined		
„ „ Max. 2 p.c. carbon	£33 10 0	10/–
„ „ „ 1 p.c. carbon	£38 0 0	13/6
„ „ „ 0·70 p.c. carbon	£39 0 0	15/–
„ „ „ carbon free	11d. per lb.	
Metallic Chromium	2/7 per lb.	
Ferro Manganese (per ton)	£11 15 0 for home	
„ „ „	£11 0 0 for export	
„ Silicon, 45 p.c. to 50 p.c.	£11 10 0 scale 5/– per unit	
„ „ 75 p.c.	£19 0 0 scale 7/– per unit	
„ Vanadium	12/9 per lb.	
„ Molybdenum	4/2 per lb.	
„ Titanium (carbon free)	9d. per lb.	
Nickel (per ton)	£170 to £175	
Ferro Cobalt	9/6 per lb.	

FUELS.

SCOTLAND.
Prices not stable.)

	Export.
LANARKSHIRE—	
(f.o.b. Glasgow)—Steam	12/6
„ „ Ell	13/6
„ „ Splint	14/6 to 16/–
„ „ Trebles	13/–
„ „ Doubles	12/6 to 13/–
„ „ Singles	12/–
AYRSHIRE—	
(f.o.b. Ports)—Steam	13/3
„ „ Jewel	16/–
„ „ Trebles	13/6
FIFESHIRE—	
f.o.b. Methil or Burntisland—Steam	10/9 to 11/9
Screened Navigation	16/6 to 17/6
Trebles	13/– to 14/–
Doubles	12/6 to 13/–
Singles	12/–
LOTHIANS—	
(f.o.b. Leith)—Best Steam	11/–
Secondary Steam	10/9
Trebles	13/– to 13/3
Doubles	12/9 to 13/–
Singles	11/6 to 11/9

ENGLAND.

(8) N.W. COAST—	
Steams	20/6 to 21/–
Household	32/– to 51/–
Coke	20/– to 21/–
NORTHUMBERLAND—	
Best Steams	13/6
Second Steams	12/–
Steam Smalls	10/– to 10/6
Unscreened	12/6
Household	25/– to 37/–
DURHAM—	
Best Gas	14/9 to 15/–
Second	12/9 to 13/–
Household	25/– to 37/–
Foundry Coke	24/– to 26/–

SHEFFIELD—	Inland.	
Best Hand-picked Branch	24/– to 25/6	—
Derbyshire Best Bright House	19/– to 21/–	—
Best House Coal	18/– to 19/6	—
Screened House Coal	16/– to 17/–	—
„ „ Nuts	14/– to 16/–	—
Yorkshire Hards	14/– to 15/6	—
Derbyshire Hards	14/– to 15/6	—
Rough Slacks	8/6 to 9/–	—
Nutty Slacks	7/– to 8/–	—
Smalls	3/– to 5/–	—
Blast-furnace Coke (Inland)	15/6 on rail at ovens	
Furnace and Foundry Coke (Export), f.o.b.	17/– to 18/6	

(9) SOUTH WALES.

CARDIFF—	Export.
Steam Coals :	
Best Smokeless Large	20/–
Second Smokeless Large	18/9 to 19/9
Best Dry Large	18/6 to 18/9
Ordinary Dry Large	17/6 to 18/–
Best Black Vein Large	18/3 to 18/6
Western Valley Large	18/– to 18/3
Best Eastern Valley Large	17/9 to 18/–
Ordinary Eastern Valley Large	17/6 to 17/–
Best Steam Smalls	13/3 to 13/6
Ordinary Smalls	11/6 to 12/9
Washed Nuts	19/– to 22/–
No. 3 Rhondda Large	20/– to 20/6
„ „ Smalls	15/6 to 16/–
No. 2 „ Large	17/– to 17/3
„ „ Through	16/– to 16/6
„ „ Smalls	14/– to 14/3
Foundry Coke (Export)	27/6 to 37/–
Furnace Coke (Export)	21/– to 21/6
Patent Fuel	22/–
Pitwood (ex ship)	26/9 to 27/3
SWANSEA—	
Anthracite Coals :	
Best Big Vein Large	35/– to 37/6
Seconds	27/– to 31/6
Red Vein	23/6 to 27/–
Machine-made Cobbles	41/6 to 45/–
Nuts	40/– to 46/–
Beans	24/6 to 27/6
Peas	20/– to 21/–
Breaker Duff	10/– to 10/6
Rubbly Culm	11/3 to 11/9
Steam Coals :	
Large	19/6 to 21/6
Seconds	18/– to 19/6
Smalls	12/– to 13/–
Cargo Through	15/6 to 16/–

(1) Delivered. (2) Net Makers' Works. (3) f.o.b. Makers' Works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire, and Ayrshire. (6) Home Prices—All delivered Glasgow Station. (7) Export Prices—f.o.b. Glasgow. (8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. (*a*) Delivered Glasgow. (*b*) Delivered Sheffield. (*c*) Delivered Birmingham. (*d*) Rebate: Joists (minimum), 12/6; Ordinary Ship, Bridge, and Tank Plates and Sections, 10/– if home consumers confine purchases from associated British Steel Makers. (*e*) Delivered Black Country stations.

French Engineering Notes.

(From our Correspondent in Paris.)

Aeroplane Accidents.

A series of fatal accidents in the military air service has left a painful impression upon the public which is asking whether the arrangements to ensure a minimum of risk are all that they should be. On one day last week there were three accidents. Near Chartres, a bombing plane lost speed and fell on a village, the six occupants being killed. Shortly afterwards, one of the engines of another machine broke away. Then, near Dijon, a biplane with four engines got into difficulties through the control gear of the elevating plane breaking, and, for reasons not satisfactorily explained, there was an explosion and the machine collapsed. Two men escaped with parachutes, though seriously injured, and four others were killed. Seeing that the problem of security is in the forefront of the policy of the Air Ministry, which controls both civil and military aviation, it is feared that the methods employed to make flying safe are inadequate, and if that were the case the situation would be serious, for the precautions that are supposed to be taken should reduce the risk of accident to a minimum. The accidents are due both to structural defects and to the insufficient preparation of pilots, and where so much depends upon the personal factor, not only in flying but also in skilled supervision, it is difficult to ensure a maximum of safety so long as men are drawn from a short service army. In the military air service there have been 129 serious accidents, involving the loss of seventy-four lives and serious injuries to eighty-seven men for 246,211 flying hours.

Labour Troubles.

The strikes in the Lille and Roubaix districts are still dragging out for reasons that are not clearly defined, as one pretext after another is found by the men's union to continue the struggle. The trouble first arose out of a claim for an advance in wages to cover the men's weekly contribution under the compulsory insurance scheme. When that was found to be illegal, the union declared that the strike was to make up for the increased cost of living, and it appeared to be settled by the employers undertaking to concede the claim if an official inquiry showed that living costs had really increased sufficiently to justify higher wages. That did not satisfy the union, which demanded a suppression of what is called the "fidelity premium." Owing to the shortage of labour in the textile industry, so much trouble was experienced through the means employed to draw men from one factory to another, that employers offered premiums to men who remained in the factory for at least a year. The union objected to this premium because it was alleged to be derogatory to the men's dignity. It tied them down and deprived them of their liberty, and, in a general way, "brought the men to slavery." It is this attitude of the union, with its communistic sentiment, which makes the labour situation disquieting. The employers' federation is determined to adhere strictly to the undertaking which the men accepted and are now repudiating, and it has been stated that unless the men give way there will be a lock-out in the textile industry.

The Colonial Exhibition.

The International Colonial Exhibition which will be held in the Bois de Vincennes, Paris, next year, will be more particularly a demonstration of French achievement in the building up of a vast colonial empire, and as most of this work has been done within the past ten years the results shown at the Exhibition will be instructive. It is only within recent years that the French public has become impressed with the value of the colonial possessions, while manufacturers are looking to the colonies to provide them with a considerable percentage of their trade, not only in the supply of engineering material for the construction of railways, ports and the installation of factories, but also as a source of raw material which at present has to be purchased abroad. Some of the undertakings, such as the irrigation of the Niger Valley for the production of cotton, are amongst the largest of their kind. It is probable that full data will be available at the Exhibition concerning the proposed Trans-Saharan Railway, and as the Government does not seem disposed to make any move in the matter, despite the favourable report of the expert commission, it may be assumed that the project will remain in abeyance until after the Exhibition. Practically all the foreign colonial Powers will be represented in the Bois de Vincennes. Most of the buildings are well advanced, and amongst the permanent constructions are the colonial museum and the buildings of some colonial Governments. The temporary structures are mostly of light steel joists, covered with timber, and the purely decorative constructions are of timber covered with wire netting to receive the rough cast plaster.

Shipbuilding Material.

Shipbuilders have been obtaining most of their supplies of ship plates, angles, and channel sections from British steel makers, who have lately secured some further orders. The use of British steel is due to the facts that prices at the ports are generally lower than that of native steel, and that French makers are unable to supply the special dimensions required in a reasonable time. Negotiations have been carried out recently between shipbuilders and steel makers with the idea of facilitating the supply of native steel to the shipyards, and they have now a ranged to standardise angles to dimensions approximating to the British sizes now employed, though no change has been made in channel iron. Shipbuilders have undertaken to limit the number of sizes in use and to distribute orders in a way to give French makers a chance of competing with British steel. The adoption of new standards will obviously be to the advantage of French steel works, but in the case of channel and some other sections, they can only lay themselves out to supply the material if there is a sufficiently large demand.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

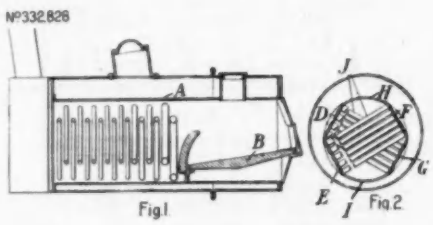
Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

STEAM GENERATORS.

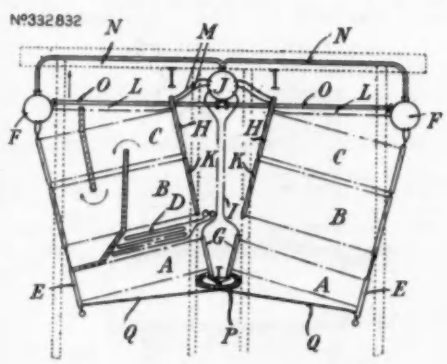
332,828. October 8th, 1929.—Steam Generators, Edwin Richard Foden, and Fodens, Ltd., both of Elworth Works, Sandbach, Chester.

The steam generator described in this specification is of the horizontal type, comprising a cylindrical shell and an internal furnace tube A secured to the boiler end plates. The tube A is cylindrical at the part where the fire-grate B is situated, but at the rear of the fire-grate it is shaped as shown in Fig. 2. There are four flat surfaces, D, E, F, and G, in two pairs, the latter being connected by curved parts H and I of the furnace tube at the top and bottom of the latter. The water tubes J are expanded at their ends into the flat parts of the furnace tube. The tubes are arranged in rows which cross one another. The tubes in the different rows may vary in number and diameter, the tubes in the rows nearest to the fire-grate being of larger diameter and fewer in number than the tubes in the remote rows. There are seventeen rows of tubes. The front two rows may contain four tubes in each, the succeeding four rows contain five tubes in each and the remaining eleven rows contain six tubes in each. The inventors do not, however, limit themselves to any particular number of rows of tubes nor to any particular number of tubes in the various rows.—*July* 31*st*, 1930.



332,832. October 14th, 1929.—Water-tube Boilers, Babcock and Wilcox, Ltd., of Babcock House, Farringdon-street, London, E.C. 4, and Christopher Humphrey Davy, of 24, Kidbrook-grove, Blackheath, London, S.E. 3.

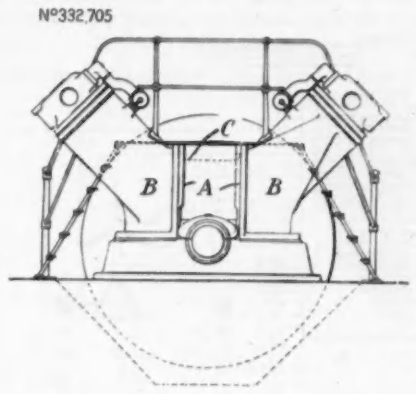
Each half boiler described in this specification comprises three banks of tubes, A, B, and C, of which the upper banks B and C are spaced from the lower bank A to afford space for an interbank superheater D, each bank being connected at its end with uptake and downtake headers. The downtake headers E are connected with the steam and water drum F of each half boiler. The uptake headers G of the lower bank of tubes A in lieu of being connected with the uptake headers H and K of the banks B and C, are connected by means of tubes I at their upper ends direct with a steam drum or receiver J common to both half boilers and arranged at a level such that its lowermost point is above the highest water level in the steam and water drums F. The uptake headers H and K of the upper banks B and C are connected with the steam and water drums F by means of return tubes L arranged beneath the upper ends of the uptake headers and the uptake headers H and K are connected by means of tubes M, with the common steam drum or receiver J at a level above that at which the return tubes L are connected with the uptake headers. As a result, re-circulation of the water within the sections takes place while the steam is separated in the headers, and steam relatively free from moisture is delivered to the common steam drum or receiver. The common steam drum or receiver is connected by steam pipes N with each of the steam and water drums, thereby ensuring a pressure balance between the drums. The steam drum J is, moreover, connected at its lower end by pipes O with the steam and water drums to ensure that any water discharged by the uptake headers into such steam drum or receiver will be returned to the steam and water drums. Between the uptake headers of the two half boilers there is a brickwork arch P in which the tubes interconnecting the two half boilers are embedded. This arch is water cooled by means of the tubes Q, which extend between the uptake headers of one half boiler and the downtake headers of the other half boiler and thus provide a connection between the water spaces of the boiler.—*July* 31*st*, 1930.



INTERNAL COMBUSTION ENGINES.

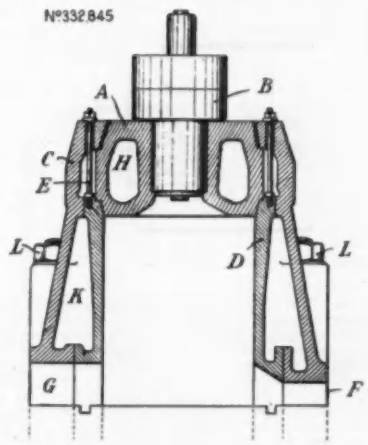
332,705. June 22nd, 1929.—Internal Combustion Engines of the V Type, George Mills Blackstone, Frank Carter, and Evershed Carter, all of Rutland Engineering Works, Stamford.

The object of this invention is to provide means for adequately staying the cylinders of V type internal combustion engines, and at the same time allowing ready access to the crank pin bearings, pistons, and main bearings. According to the invention, distance plates or pieces are used, to which the housings carrying the cylinders, together with the upper portion of the crank case, are bolted, as well as to the base plate of the engine. These plates may be arranged either horizontally or vertically. In the case of a large engine the housings are divided vertically and a number of vertical distance plates arranged in the division in such a manner that on their removal gaps sufficiently wide to allow of the removal of the pistons and connecting-rods, main bearing caps and brasses are formed. Horizontal distance plates may also be used to join the tops of the housings and provide additional stays. In small engines the cylinders and housings of which can be easily handled the vertical distance plates may sometimes be dispensed with. A are vertical distance plates joining the housings B B and C are horizontal distance plates staying the upper portion of the housings. On removing the distance plates C and A, the gap is sufficiently wide to allow of the removal of the main bearing caps, pistons and connecting-rods.—*July* 31*st*, 1930.



332,845. October 30th, 1929.—Cylinders for Internal Combustion Engines, Sulzer Frères Société Anonyme, of Wintherthur, Switzerland.

This invention relates to cylinders for double-acting internal-combustion engines and has for its object to provide a construction which will obviate the use of heavy screw-threaded bolts in the cover of the cylinder. The cylinder cover A is provided with a central removable plug B or fitting adapted to receive such parts as the starting and injection valves. The inner end of the cover is supported on the cylinder liner D, the outer portion of the cover being engaged by the overlapping portion of the cylinder casing or jacket C. The cylinder jacket is secured to the liner by means of screw bolts E, which are disposed outside the circumferential periphery of the cover. The cover is provided with a cooling chamber H and similar cooling chambers are provided at K between the cylinder jacket and its liner. The cylinder is transversely divided through the inlet ports F and the outlet ports G, and the liner is similarly divided, the upper and lower portions of the cylinder being connected together by means of bolts L, the arrangement being such that after the nuts of these bolts have been released the upper portion of the cylinder can be removed as a unit without removing the cylinder head or breaking any joints for the water jackets. The construction of cylinder heads according to this invention obviates the use of heavy bolts hitherto employed for bolting the cylinder cover in position. These bolts were exposed to tension and their dimensions and relatively large number materially increased the cost and difficulty of making the cylinder. The cylinder cover, according to this invention, is held between the cylinder casing or jacket and the liner of the cylinder without the screw bolts E being exposed to the forces which act on the cylinder cover. The bolts E have only to ensure a tight joint between the liner and the cylinder cover and to hold together the cover, jacket, and liner which together form the upper removable cylinder unit. A cover according to this invention can be of reduced dimensions as the forces acting upon it are transmitted directly to the casing or jacket of the cylinder.—*July* 31*st*, 1930.

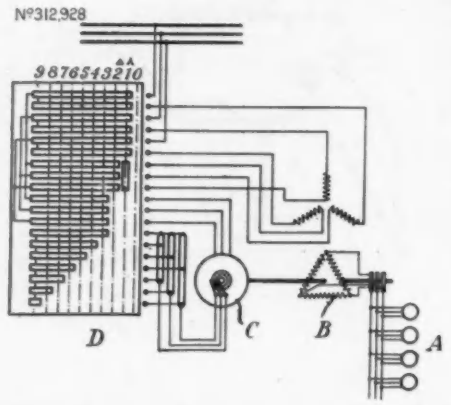


DYNAMOS AND MOTORS.

312,926. May 31st, 1929.—Starting Small Electric Motors, Siemens-Schuckertwerke Aktiengesellschaft, of Berlin-Siemensstadt, Germany.

This specification describes an improved method of driving spinning motors. The small motors A are the spindle motors of a spinning machine, and are fed through a frequency transformer, which consists of an asynchronous generator B and a driving motor C. The motors A are permanently connected to the slip ring of the asynchronous generator B. The frequency transformer and consequently the small motors attached thereto are controlled by a switch drum D. In the position 0 the transformer is switched off. In the position 1 the stator of the asynchronous generator B is connected in star to the network. The driving motor C of the frequency transformer is in this case switched out. The result of this is that the asynchronous generator B runs at a high speed as motor, and in this case the small motors A connected to serve as a rotor resistance. Owing to the star connection of the stator of the asynchronous generator B, the secondary tension of the generator is so far reduced that the small motors cannot start up. Owing to the high speed of the generator as a motor with decreasing slip frequency

the secondary tension also decreases to a corresponding extent. When the frequency transformer has been started up in this way, the switch drum D is switched over into the position 2, and the stator of the asynchronous generator is connected in delta. Owing to this, the secondary tension increases; but, owing to the reduction of the slip frequency by the running at high speed, it is not possible to produce a sufficiently high tension in the secondary circuit, in which the small motors lie,

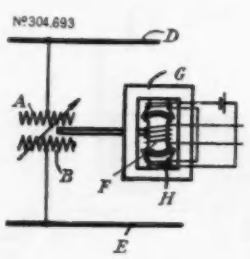


to start up these motors. In the further positions 3 to 9 of the switch drum, the motor C of the frequency transformer can be switched in and regulated, either by driving the asynchronous generator B with the field or against the field, and thus causes the running of the small motors A at a high speed. The small motors are thus governed exclusively by one single controlling drum and easily regulated by controlling the frequency transformer.—*July 31st*, 1930.

TRANSMISSION OF POWER.

304,693. January 22nd, 1929.—AN ARRANGEMENT FOR LIMITED POWER TRANSMISSION IN ELECTRIC NETWORKS, Siemens-Schuckertwerke Aktiengesellschaft, of Berlin-Siemensstadt, Germany.

For the purpose of protecting transmission devices from overload, when transmitting power from one network to another of the same frequency, the power transmission frequency must not exceed a given value, and for this purpose it has been already proposed to couple the networks together by means of a transformer, the secondary part of which is mounted in a rotatable manner and provided with a locking device which is released when a predetermined power transmission is exceeded. According to this invention, a transformer A, having a rotatable

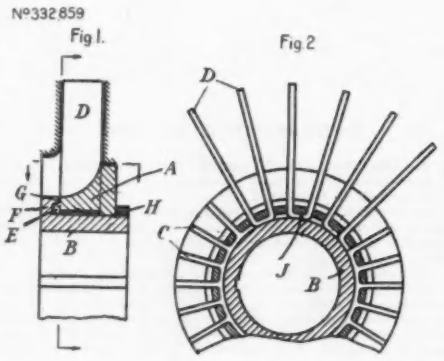


secondary part B, is inserted between the two networks D and E, to be coupled together. The movable secondary B, which is normally held stationary and is only turned into a fresh position when the power transmitted by the transformer deviates from a predetermined amount, is coupled to a movable armature F of a direct-current motor G, which is adjusted to develop sufficient torque to hold the secondary B stationary under normal conditions. For this purpose the motor has a fixed field coil H. This fixed coil, as well as the coil F on the movable armature, are excited by means of direct current, and the torque exerted on the rotatable secondary part of the transformer A can be set, by modifying the excitation, to any desired value.—*July 22nd*, 1930.

PUMPING AND BLOWING MACHINERY.

332,859. November 14th, 1929.—CENTRIFUGAL COMPRESSORS AND PUMPS, Siemens-Schuckertwerke Aktiengesellschaft, of Berlin-Siemensstadt, Germany.

In order to simplify the fixing of the blades of centrifugal compressors and pumps, it has been proposed to insert the blades of the disc in a blade holder which is provided with slots

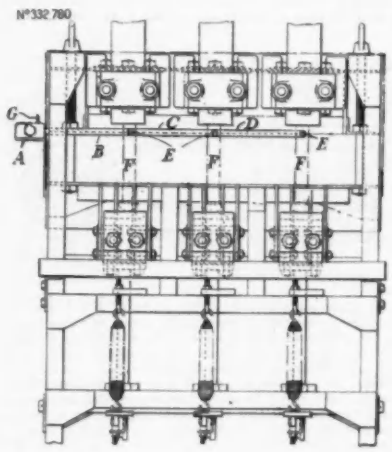


which correspond to the cross section of the blades. The blades are held positively in the slots. The blade holder described in this specification has an annular body A mounted on the hub B. In the body there is an annular groove with adjoining radial grooves or slots C. Into these grooves the blades D are inserted. The blade holder A is provided with an annular projection, the outer surface of which is conical. The hub B is formed with a ring F, which is provided with an annular projection G forming a counterpart of the projection E. When the blade holder is pushed to the left, the projection E engages under the projection G and is prevented by the latter from moving out under the action of centrifugal force. By tightening the nut H all the parts are firmly clamped. A further fixing or clamping may be effected by making the blade roots or portions J of slightly larger size than a good fit, so that during the tightening of the nut they are firmly pressed against the inner recess of the blade holder A. On the right of Fig. 2 an alternative form of blade is shown.—*July 31st*, 1930.

MACHINE TOOLS AND SHOP APPLIANCES.

332,780. August 17th, 1929.—ELECTRIC HEATERS FOR RIVETS AND OTHER WORK PIECES, British Insulated Cables, Ltd., of Prescot, Lancashire, and Lionel Bray Wilson, of Redgate, Eccleston Park, Prescot, Lancashire.

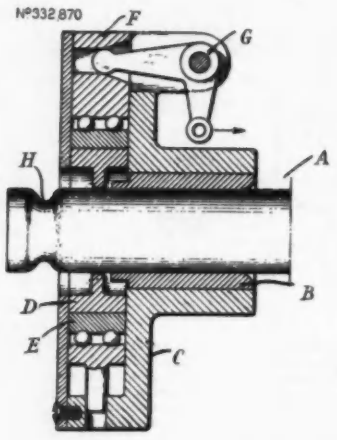
This invention relates to heaters of the kind in which a heavy electric current passes through the rivet or other work piece of varying cross section, and the resistance offered by the work piece to the passage of this current causes heat to be generated in such work piece. The invention has for its object to provide an improved form of apparatus for obtaining a substantially



uniform heating effect throughout the work piece. In order to ensure a uniform heating of rivets, a box A is provided with three separate pipes B, C, and D respectively, each of which has a branch pipe E terminating at points in proximity to the respective upper ends of the rivets F, that is to say, in proximity to the ends remote from the heads of the rivets. Each of the pipes is fitted with a control tap G. The box is connected to a suitable source of supply of air under pressure, and the air blast directed on to the ends of the shank portions of the rivets.—*July 31st*, 1930.

332,870.—December 4th, 1929.—THE MANUFACTURE OF CORRUGATED TUBES, O. Meyer-Keller & Cie., Aktiengesellschaft, of 45, Kellerstrasse, Lucerne, Switzerland.

This invention relates to a process and apparatus for the manufacture of corrugated tubes from plain tubes of thin metal, or of materials that can be worked in the same way as metal. A denotes a thin-walled metal tube, slidably mounted in a guide bush B on which the head C is set in rotation. D is a profiled pressure ring, which is securely mounted in the inner race E of a ball bearing carried by the head, whilst F denotes a lug on the outer race of the ball bearing, the lug being provided with a hole



for the engagement of a bell crank lever G. Moving the lever G in the direction of the arrow during the rotation of the head C displaces the ball bearing E radially in relation to the axis of the tube, and thus effects the rolling of the corrugation troughs H in the tube by the action of the profiled pressure ring D. After each trough is formed, the tube is fed forward and the pressure ring is again operated to form the next trough. The cylindrical portions between the rolled corrugations are transformed into the crests of the corrugations by subsequent upsetting. It is also possible to allow the tube to rotate, in which case the head C remains stationary, or the tube may be turned in one direction and the head in the other.—*July 31st*, 1930.

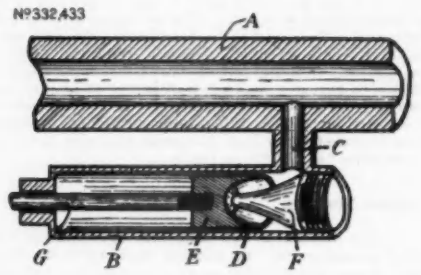
MISCELLANEOUS.

310,061. April 20th, 1929.—THE PRODUCTION OF TIN-PLATE, Rasselsteiner Eisenwerks-Gesellschaft Aktiengesellschaft, of Neuwied-Rasselstein, Germany, and Heinrich Främbs, of Neuwied-Rasselstein, Germany.

This invention relates to a process for the annealing of plates in the production of tin-plate, wherein the plates are successively pickled, annealed, polished, pickled, and finally tinned. It has been proposed in the production of tin-plate to provide a continuous annealing plant through which the plates are adapted to pass singly, but in this case no indication was given of the temperatures to be used. In the annealing process according to the present invention, the plates are heated either singly or in small packages to a temperature of approximately 900 deg. Cent. in the plate or plate packet. In spite of the high temperature employed in this annealing process, there is no danger of the plates becoming welded together, owing to the low height of the packages in which the plates are heated. For the same reason the time required for cooling is much shorter than that required when the plates are stacked in high piles for heating. By increasing the annealing temperature to approximately 900 deg. Cent., the quality of the tin-plate produced is said to be considerably improved, and, in addition, there is hardly any waste due to the tearing of the plates on further working. Furthermore, a saving in tin is effected as the plates annealed according to the invention can be very highly polished and therefore require a thinner coating of tin than hitherto necessary to protect them from corrosion.—*July 21st*, 1930.

332,433. August 23rd, 1929.—PISTON FOR GAS-OPERATED AUTOMATIC FIREARMS, Joseph Destree, of 123, Chaussée Saint Pierre, Brussels, Belgium.

In gas-operated firearms with a gas intake from the bore of the barrel the pistons frequently become jammed in the cylinder which contains them. Moreover, they wear considerably on account of the powder deposit with which they come into contact, and the object of this invention is to overcome these disadvantages. This drawing shows the end of the barrel A of the firearm, which is in communication with a cylinder B through



a duct C. The gases which enter the cylinder through this duct act upon the front incurved face D of a piston E, and they may be led on to the face D by means of a conical guide F. The piston E has a sufficiently smaller diameter than the internal diameter of the cylinder B to leave a free clearance between the piston and the cylinder wall. The rod G, by means of which the piston E is connected to the automatic action mechanism, is guided in such a way as to prevent any contact between the outer surface of the piston E and the inner wall of the cylinder B. This guide may be provided, for example, at the rear end of the cylinder B.—*July 24th*, 1930.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY TO WEDNESDAY, SEPTEMBER 10TH.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.—Bristol meeting. The presidential address, by Professor F. O. Bower, will deal with "Size and Form in Plants." Evening discourses will be given by Professor E. V. Appleton, F.R.S., on "Wireless Echoes," and by Dr. R. E. Slade on "The Nitrogen Industry and our Food Supply." Evening receptions and excursions to points of scientific interest, works, &c., in the locality will be arranged.

THURSDAY, SEPTEMBER 4TH, TO SUNDAY, SEPTEMBER 7TH.

INTERNATIONAL CONGRESS OF CONSULTING ENGINEERS.—Fifth Congress at Vienna.

TUESDAY, SEPTEMBER 9TH, TO FRIDAY, SEPTEMBER 12TH.

INSTITUTE OF METALS.—Annual Autumn Meeting, Southampton. Continued from September 13th to September 16th by a visit to France. The meetings at Southampton will be held in the Chantry Hall, and on September 9th Professor D. Hanson will read a paper on "The Use of Non-ferrous Metals in the Aeronautical Industry." 8 p.m. For programme see page 88.

SATURDAY, SEPTEMBER 13TH, TO SATURDAY, SEPTEMBER 20TH.

LIVERPOOL.—Centenary celebrations of the Liverpool and Manchester Railway.

WEDNESDAY, SEPTEMBER 17TH, TO WEDNESDAY, OCTOBER 1ST.

BUILDING TRADES EXHIBITION.—At Olympia, London.

SUNDAY, SEPTEMBER 14TH, TO WEDNESDAY, SEPTEMBER 17TH.

NEWCOMEN SOCIETY.—Summer meeting at Liverpool.

FRIDAY, SEPTEMBER 19TH, TO SUNDAY, SEPTEMBER 21ST.

WOMEN'S ENGINEERING SOCIETY.—Lady Margaret Hall, Oxford. Eighth annual conference.

FRIDAY AND SATURDAY, SEPTEMBER 26TH AND 27TH.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—Southern District meeting at Southampton. Friday: 10 a.m., assemble at Audit House. Official welcome by the Mayor of Southampton, Mr. Councillor H. Young. Description of works by Mr. S. G. Stanton, Borough Engineer and Surveyor and Housing Architect. 11 a.m. to 1 p.m., visits to various works being carried out by the Corporation. 1.30 p.m., arrive at South-Western Hotel for lunch by the invitation of the Mayor and Corporation. Saturday: 9.30 a.m., assemble at South-Western Hotel. Discussion on paper, "Municipal Undertakings." 11 a.m., inspection of Southern Railway Company's new dock works, Western Esplanade. 1 p.m., luncheon at South-Western Hotel. 3 p.m., assemble at the Ocean Dock, Entrance No. 2 Gate, Southampton Docks, for an inspection of R.M.S. "Majestic."